WORLD PETROLEUM

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W.P. Staff Photo

OIL AT THE FAIR—*The above picture and that on the front cover of this issue show the Petroleum Industry Exhibit at the New York World's Fair of 1939. The oil derrick, which is to feature actual drilling operations throughout the period of the fair, towers 200 ft. above the ground. The triangular metal building, 200 ft. on each side and rising 80 ft. in the air, houses the industry's exhibits, mainly of an educational nature. Fifteen leading oil companies abandoned plans for individual exhibits in order to form Petroleum Industry Exhibit, Inc.*

EDITORIAL

SANCTITY OF COURTS IN BOLIVIA

"IT IS precisely in these moments that we must make known to the justices of the Supreme Court our decision to tear out their entrails and burn their blood if perchance they rule against the sacred interests of the nation and in favor of the Standard Oil Company," said the Director General of National Police of Bolivia, broadcasting over the Bolivian Government radio station on February 18, 1939.

At that time the Bolivian Supreme Court had under consideration an appeal by Standard Oil Company of Bolivia against provisions of a decree expropriating the company's entire possessions in Bolivia. The company had spent some $17,000,000 in geological work, drilling 28 wells, building two small refineries, extensive roads, camps and sanitation facilities.

Three weeks after the above statement by the Director General of Police, which was simply the climax in a campaign of suppression and vilification directed at Standard of Bolivia, a recently reorganized and thoroughly intimidated Supreme Court dismissed the company's appeal on the grounds that it did not have legal standing in court. No decision was rendered on the point in question which was based on the fact that arbitrary revocation of an agreement by one party violated the contractual rights of the other.

The condition from which the company was seeking relief grew out of confiscation of its properties by a decree signed by the President and his Cabinet. The decree was based on a claim that the company had exported oil in 1925-26 and had therefore reached the production as opposed to the exploratory stage of development. That the company had allegedly concealed this transaction and had not paid the higher scale of surface rental when this so-called exportation was initiated was claimed to constitute a fraud and be sufficient grounds for confiscation.

Inasmuch as the seizure was justified solely on these two points it is of interest to examine their validity. It also raises the point of the clandestine pipeline said to have carried production from Standard's wells in Bolivia into Argentina. In 1925 Standard of Bolivia had completed a small producer near the Argentine border. Standard of Argentina was drilling a wildcat across the border in Argentina. Permission was obtained from the Argentine Government and the necessary clearance from Bolivian customs to construct a small temporary pipeline from the Bolivian well to the Argentine location. The sole purpose of this line was to supply fuel for the boilers of the wildcat. Less than 5,000 bbl. were transported across the river. Within ten months the pipeline was dismantled, as operations had been completed. No facilities existed for shipment of oil from the Argentine location to outside markets. The whole operation of the pipeline was carried on with the full knowledge of both governments. Subsequently when the question of Bolivian oil being imported into Argentina was raised on the floor of the Argentine Congress, a commission was appointed, visited the region and reported the accusations to be utterly without foundation.

The second point justifying the confiscation decree, the question of fraud, arose out of a previous contract no longer in force. In the contract of 1920 between Richmond Levering Company and the Bolivian Government there had existed a clause giving the government the right to declare the concession forfeit in case of fraud. This clause was specifically eliminated from the new contract of 1921 when Richmond Levering transferred the concession to Standard of Bolivia. The transfer and the elimination of the clause were approved by the Government in July, 1922.

In any event the clause covering increased surface rental existed only in the Standard of Bolivia

contract of 1921 while the clause covering the right of the government to seize the concession in case of fraud existed only in the Richmond Levering contract of 1920. The Bolivian administration had based its confiscation decree on two clauses from two different contracts which by their very nature were mutually exclusive.

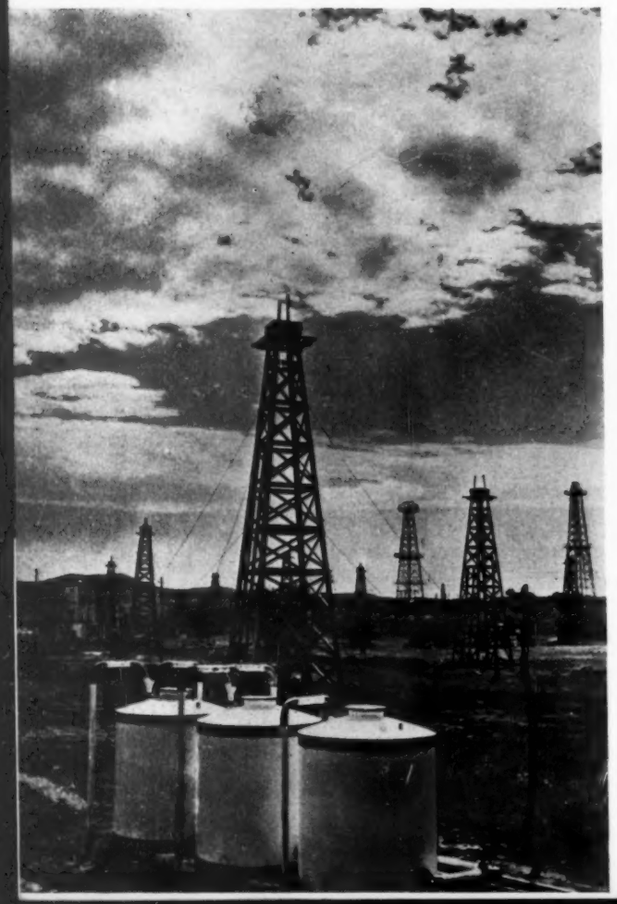
When the Bolivian Supreme Court rejected the company's appeal on March 8, 1939, refused to reconsider and stated that all avenues of legal relief in Bolivia were closed, the company appealed to the U. S. State Department. The State Department has been requested to seek a return of the properties or submission of the case to international arbitration.

If vigorous action is not taken at once by the U.S. State Department to secure relief for this violation of American rights, serious harm will be done to the national interests of the United States.

That such action is urgently necessary is shown by the announcement that Bolivia, together with its late antagonist Paraguay, is negotiating with Germany to exchange oil from the confiscated properties for pipeline and refinery equipment, the plan contemplating the erection of a refinery in Paraguay. The implications of this arrangement are too obvious to require comment.

Control of ALBANIAN OILFIELDS Assures 4% of Italy's Crude Requirements

Military Occupation and Inclusion of Albania in the Italian Empire Raises Question of Its Petroleum Significance to Italy.



Albanian oil in storage to supply the pipeline which will carry the oil to the Adriatic and finally to Italy in Italian tankers.

"THE fact that Italy is willing to spend much capital, energy and time developing this small production despite the fact that purely commercial interests have given it up, make it evident that she is not looking so much for a profit-making enterprise as for the establishment of a permanent military fuel oil base, one which would be readily accessible at all times for her warships and airplanes," said Rudolph Seiden writing in WORLD PETROLEUM for May 1937. "The limit of Albanian oil reserves has been liberally estimated at 70,000,000 bbl., and it has been suggested that while Europe could meet its oil demand for only a few weeks Italy's supply in Albania would last about five years. This would indeed be so if the potential production could be obtained within this period—unfortunately for Italy, however, the crude oil reserves in that country are far more likely to last ten times that long, but with an output in proportion to the life of flow and steadily diminishing with the years."

With a crude oil output in 1938 of 72,166 tons, Albania supplies but four percent of the annual Italian demand for 1,830,000 tons. General Serrigny, head of the association representing the petroleum industry of France and a former member of the Supreme Defense Council of that country, has estimated that wartime demand in Europe would be at least two and a half times normal peacetime requirements. In the event of war therefore Albanian production would be an insignificant factor in Italy's demand for petroleum, amounting to 4,575,000 tons.

In view of recent developments within the Italian Empire and the tense situation in Europe, it is of interest to examine the potentialities of Albanian reserves.

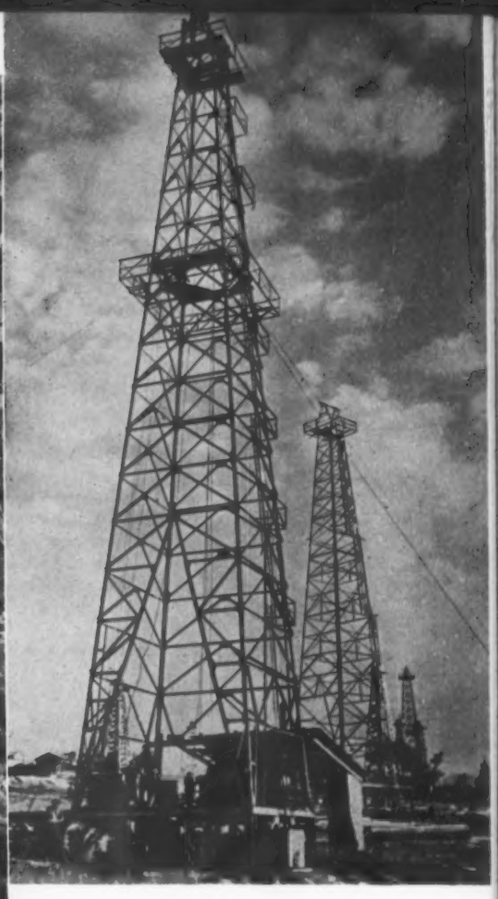
The possible existence of petroleum resources in Albania was recognized at the end of the Great War. Various French and British concerns acquired concessions and did some exploration without success. Because of its collaboration in the reconstruction of the Albanian government, and because of its favorable geographic position on the other side of the Adriatic, the Italian government became interested in the matter and secured concessions for prospecting in certain zones which had been defined by accurate studies by Italian geologists.

For carrying out the prospecting and for eventual exploitation of oil that might be found, in 1925 the Italian Ministry of Communications organized a company: Azienda Italiana Petroli Albania, "A.I.P.A.," as an organism of the administration of the Government Railways.

While the Italian company is the only one which has actively exploited the Albanian deposits, concessions were granted in 1925 to Anglo-Iranian (then Anglo-Persian) and later to Standard Oil Company of New York and to Franco-Albanaise Syndicate. This company, representing French interests, later changed its name to Soc. Industrielle et Commerciale des Pétroles. A concession was also granted to Henry H. Rushton, an English oil man.

All these concessions were subsequently forfeited but late in 1936 the French company renewed its interest by depositing 35,000 gold francs with the Albanian government. This company then drilled two wells at Korce, one at Mavrova and a fourth near Devoli. The French company has since become inactive in Albania.

A central pumping power in the Devoli field in Albania and a general view of the field.



Modern rotary in the Devoli field operated by the Italian government company Azienda Italia Petroli Albania.

The total area of land included in the concessions obtained by the Italian government company A.I.P.A. for oil prospecting amounted to about 164,000 hectares, (393,000 acres) distributed in three zones: (1) the coastal zone, (2) the Vojussa or intermediate zone, and (3) the interior or Devoli zone.

Beginning in 1925 exploratory wells were put down in the coastal zone some of which reached a depth of about 1,500 meters. These turned out to be either dry or of no importance as commercial oil wells. Analogous results were obtained in the Vojussa or intermediate zone.

In 1927 drilling was begun in the interior zone near the Devoli river. Here the local conditions were rather difficult on account of distance from centers of supply, absence of roads and repair shops, and lack of ordinary living facilities. Here one of the first wells yielded results by penetrating a sand impregnated with a very dense crude oil having an asphaltic base. Following on this encouraging result other exploratory wells were put down, using the slow percussion equipment available at the time. This led to further drilling and to further geological and geophysical studies for defining the field and finally resulted in commercial production in the second half of 1935.

On the mechanical side, after a conclusion was reached regarding the most desirable annual rate of production, it was found necessary to adopt a more speedy drilling system. A change was therefore made to rotary outfits especially adapted to attain high footage rates to depths of 600 to 900 meters in the formations of the Devoli basin.

At the same time there was designed and installed for the first time in petroleum history, a central electric power plant for furnishing electric power to the various active fields.

Using electrically driven drilling equipment the average time for completing a well in the Devoli district is about two months. The 26 existing drilling rigs are thus able to put down new wells at the rate of about 160 a year, with a total annual meterage of about 100,000 (325,000 feet). In this respect the Devoli district compares favorably with other oil fields throughout the world.

Operations in the Albanian fields to date include drilling of a total of 28,000 meters for 57 exploratory wells, and 262,000 meters for 380 producing wells.

Albanian production has increased from 1,375 tons in 1932 to 6,152 tons in 1935. In 1936 production increased substantially reaching a total of 32,760 tons, and again in 1937 reached 56,760 tons. Preliminary figures for 1938 indicate a further increase in production which is estimated for the year at 65,313 tons. For the first quarter of 1939 daily average production at 356 tons is exceeding the 1938 figure of 201 tons.

At the same time the A.I.P.A. has had to execute numerous subsidiary works: roads, bridges, living quarters for workers and employees, churches, hospitals, recreation centers, sporting fields, offices, warehouses, electric power plant and distributing systems. All these works now make up a large industrial center and have transformed the small and primitive Albanian village of Kucova into an up-to-date town which the local authorities have lately renamed Vajguras (Petrolia).

For transporting the crude oil to the sea there has been built a pipeline 74 kilometers long. This line is of steel tubing eight inches in diameter. The main pumping station is equipped with electrically driven pumps; the pumps of the three intermediate stations are Diesel powered. At the seaboard terminus at Valona the oil is piped directly into the oil tank ships.

Under normal treatment in the Italian refineries Albanian crude oil gives a yield of 13 percent of gasoline by simple topping. It is a black asphaltic base crude and in addition to the 13 percent gasoline it yields seven percent kerosene, 18 percent gas oil and 40 percent asphalt residue. The gasoline yield is raised to 80 percent in the new plants for hydrogenation at high temperatures and pressures which the Azienda Nazionale Idrogenazione Combustibili (A.N.I.C.) has built at Livorno and Bari.

NEW FACTORS Affecting Oil Royalty Situation

By M. D. Gould

Fundamentally Sound Investment Attribute of Petroleum Industry Has Survived Checkered Career, Violent Abuses, and Is Again Attracting Attention as Inflation Hedge.

THE importance of the oil royalty to the petroleum industry is sufficiently indicated by the fact that an estimated 600,000 royalty owners collect annually about $200,000,000 in royalties, bonuses and rentals. While the status of the oil royalty has been well established, legally and financially, since the early days of the oil industry, it has developed along with the industry as a whole. The growth of petroleum into a business grossing billions; the extension of oil production from the older capitalist east to the newer less-developed regions of the mid-west and the Coast, where capital is chronically short, and the attempts in recent years to tap the capital markets of the east, have changed the royalty picture in less than a generation. Tendencies of recent years toward restriction and regulation, through proration, SEC supervision, state and federal regulation, have confronted the oil royalty situation with new problems. Criteria of valuation which have been worked out over a long period of years have to be applied in the light of the new facts.

The status of the oil royalty in the United States rests on Anglo-Saxon common law, plus oil-country custom and tradition, plus state and federal laws, plus the decisions of regulatory bodies.

Legally, the owner of land also owns all minerals existing under the surface of his land down to the center of the earth and in perpetuity. He has a right to separate the ownership of the sub-surface minerals from the ownership of the land.

It rarely happens that the owner of the land on which oil is known or believed to exist is able or willing to drill for it. Therefore, normally he signs a lease to an oil-producing company. This document creates the oil royalty. It is not a lease at all in the usual sense but a transfer of property rights in the sub-surface oil to the oil company under conditions which are, generally speaking, standardized to include the following terms: 1. duration, five years, sometimes eight or ten; 2. the oil company to drill within twelve months; 3. the company to receive a working interest amounting to 7/8ths of all oil produced out of which all expenses of production are to be paid; 4. the landowner or grantor to receive a royalty interest of 1/8th of all oil produced without deduction for any costs except certain state and federal taxes levied directly on production; 5. a rental, usually $1.00 an acre per year, which stops when production begins. Usually a bonus varying with the desirability of the acreage is paid for a renewal of the lease.

In California which is a law unto itself in many respects, there are often certain variations, the royalty being frequently expressed in percentages, not in fractions, and in some cases, ranging up to 20 percent of the production.

Similar lease and royalty arrangements are made for natural gas alone or in connection with oil but these will be disregarded in this article.

The landowner can divide his royalty interest into fractions and these, in turn, be further split up. The unit in royalty transactions is the royalty-acre, which is that part of the royalty interest represented by the number of acres in the leased tract—thus in a forty-acre lease a royalty-acre represents 1/40th of 1/8th of the total production, irrespective of whereabouts on the 40-acre plot, the producing well or wells may happen to be. For this reason, each holder of a fractional interest of the original royalty is said to have an undivided fraction, 1/2 or 1/8 or 1/32 of 1/8th (royalty) of all the oil produced from the tract under lease.

The evidence of this ownership is a mineral deed, which is a proportionate property right in the sub-surface minerals retained by the landowner subject to the lease. As a property right, its ownership is recorded in the county where the land is located and transfers of such ownership resulting from sales of royalty-interests or split-up fractions of such interests are matters of record in that county.

There are other types of interests including overriding royalties (actually deducted from the 7/8ths working interest), perpetual term, sliding scale, etc. The SEC lists eight varieties. The main division however is into producing and non-producing royalties.

When a producing well is brought in, arrangements are made with a crude oil purchasing agency, normally a pipeline company, which extends its gathering lines to the new well. It then issues a "division order" to be signed by the pipeline company, the producing company and the landowner, stating the terms under which the proceeds of the sale of the oil purchased by the pipeline company are to be divided between the royalty interests and the working interests.

Where the royalty interest has been split up, each fractional owner, on receiving his mineral deed, signs a transfer order made out to the oil company, following which he is entered on their books and entitled to

The instrument which originates the oil royalty: signed by the land owner, it grants the right to produce seven-eighths of the oil on condition that one-eighth is returned to the land owner.

OIL AND GAS LEASE

receive directly from the pipeline company, a check (usually monthly) representing his proportionate share of the proceeds of the oil produced and sold.

The legal documents involved in royalty transactions, therefore, include the oil and gas lease, mineral deed, division order, transfer order, record of pipeline runs, legal opinion on title and, where transactions are under SEC jurisdiction, an offering sheet or registration statement filed with the SEC.

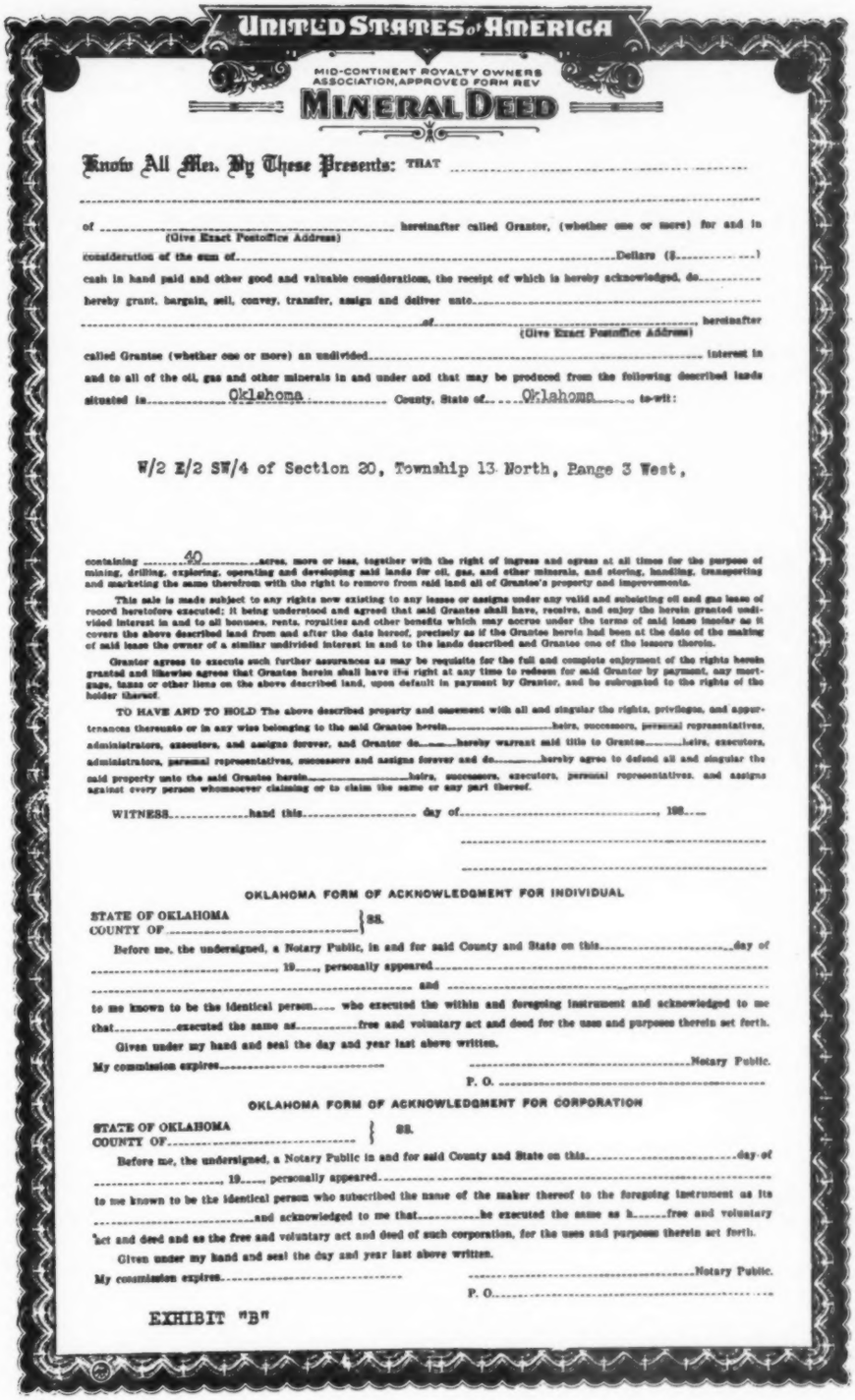
Since the royalty interest is an ownership right in oil and gas produced, its value does not depend upon the amount of profits made by or even the solvency of the producing company, except that a larger company will be assumed to have better facilities for verifying title, assuring continuity of production and better production methods. What does concern the buyer is the relation between what he puts into the royalty investment and what he gets out of it.

An obvious fallacy is simply to calculate the annual return as a percentage of the investment. A thousand dollars invested in oil royalties may buy monthly checks running from $50 to $400 or even $500 a year but this does not mean that oil royalties offer an investment yield of anything like 40 or 50 percent per annum. Oil is a wasting asset, it is not replaced, and therefore, at least a part of every royalty payment must be regarded as a return of capital. U.S. Treasury regulations permit 27½ percent to be deducted as return of capital, but the actual figure may be more or less.

Royalty dealers often calculate the pay-out period, i.e., the length of time required to return the original investment after which further royalty payments begin to constitute income. The shorter this period, other things being equal, the more desirable the investment. Pay-out periods ranging from three to five years are common; as low as two years not unheard of. On the other hand, in a field under unit operation planned for a long period, offerings have been made with a pay-out of as long as 40 years although such long periods are still unusal.

Marketability of oil royalties stands closer to that of real estate than of stocks and bonds. Each parcel stands more or less on its own merits because its value depends upon a great number of individual factors. Whether a particular royalty interest can be sold and at what price, depends upon specific negotiations with an individual buyer, rather than the impersonal transactions in homogeneous units, which characterize a fully developed market.

The value of an oil royalty cannot be determined through the automatic working



UNITED STATES OF AMERICA

MID-CONTINENT ROYALTY OWNERS ASSOCIATION, APPROVED FORM REV

MINERAL DEED

Know All Men, By These Presents: THAT .....

.....

of ..... (Give Exact Postoffice Address) hereinafter called Grantor, (whether one or more) for and in consideration of the sum of.....Dollars ($.....) cash in hand paid and other good and valuable considerations, the receipt of which is hereby acknowledged, do..... hereby grant, bargain, sell, convey, transfer, assign and deliver unto.....

.....of..... (Give Exact Postoffice Address) hereinafter called Grantee (whether one or more) an undivided..... interest in and to all of the oil, gas and other minerals in and under and that may be produced from the following described lands situated in Oklahoma County, State of Oklahoma, to-wit:

W/2 E/2 SW/4 of Section 20, Township 13 North, Range 3 West,

containing 40 acres, more or less, together with the right of ingress and egress at all times for the purpose of mining, drilling, exploring, operating and developing said lands for oil, gas, and other minerals, and storing, handling, transporting and marketing the same therefrom with the right to remove from said land all of Grantee's property and improvements.

This sale is made subject to any rights now existing to any leases or assigns under any valid and subsisting oil and gas lease of record heretofore executed; it being understood and agreed that said Grantee shall have, receive, and enjoy the herein granted undivided interest in and to all bonuses, rents, royalties and other benefits which may accrue under the terms of said lease insofar as it covers the above described land from and after the date hereof, precisely as if the Grantee herein had been at the date of the making of said lease the owner of a similar undivided interest in and to the lands described and Grantee one of the lessors therein.

Grantor agrees to execute such further assurances as may be requisite for the full and complete enjoyment of the rights herein granted and likewise agrees that Grantee herein shall have the right at any time to redeem for said Grantor by payment, any mortgage, taxes or other liens on the above described land, upon default in payment by Grantor, and be subrogated to the rights of the holder thereof.

TO HAVE AND TO HOLD The above described property and easement with all and singular the rights, privileges, and appurtenances thereunto or in any wise belonging to the said Grantee herein.....heirs, successors, personal representatives, administrators, executors, and assigns forever, and Grantor do..... hereby warrant said title to Grantee.....heirs, executors, administrators, personal representatives, successors and assigns forever and do..... hereby agree to defend all and singular the said property unto the said Grantee herein.....heirs, successors, executors, personal representatives, and assigns against every person whomsoever claiming or to claim the same or any part thereof.

WITNESS.....hand this..... day of....., 193.....

.....

.....

OKLAHOMA FORM OF ACKNOWLEDGMENT FOR INDIVIDUAL

STATE OF OKLAHOMA } ss.
COUNTY OF.....}

Before me, the undersigned, a Notary Public, in and for said County and State on this.....day of ....., 19....., personally appeared..... and ..... to me known to be the identical person..... who executed the within and foregoing instrument and acknowledged to me that.....executed the same as.....free and voluntary act and deed for the uses and purposes therein set forth.

Given under my hand and seal the day and year last above written.

My commission expires..... .....Notary Public.

P. O. .....

OKLAHOMA FORM OF ACKNOWLEDGMENT FOR CORPORATION

STATE OF OKLAHOMA } ss.
COUNTY OF.....}

Before me, the undersigned, a Notary Public in and for said County and State on this.....day of ....., 19..... personally appeared..... to me known to be the identical person who subscribed the name of the maker thereof to the foregoing instrument as its .....and acknowledged to me that.....he executed the same as h.....free and voluntary act and deed and as the free and voluntary act and deed of such corporation, for the uses and purposes therein set forth.

Given under my hand and seal the day and year last above written.

My commission expires..... .....Notary Public.

P. O.....

EXHIBIT "B"

Actual mineral deed held by the royalty owner; copy of this deed is filed in the county courthouse.

of a formula. It involves too many factors, many of them dependent upon future developments, others of which are inadequately known, and, therefore, subject to individual estimation and judgment. This value is the present capital value of anticipated future payments. The amount of these payments depends upon the amount of oil in the ground, the proportion that will be extracted before the lease is abandoned, the length of time that it will take to extract the recoverable oil, the price at which the oil will be sold, not to speak of the rate of return on capital investment which is considered proper over the productive life of the property.

The current tendency is to take the amount of recoverable oil in the ground

(combination of the first and second factors above) as the basis for estimating royalty values. At one time the SEC insisted on the presentation of such estimate in royalty offering sheets, but soon found that it would have to evaluate the evaluators when several unreliable estimates were discovered, and at present, such estimates of recoverable oil in offering statements are optional.

Where the producing sand is an old well-known formation like the Wilcox, past experience as to number of barrels recovered per acre is frequently relied on. In such cases too, the older method of recovery estimate by extrapolating the rate of decline per well is also used.

More recently, the well-known formula for calculating recovery by multiplying thickness of sand, by porosity, by acreage, by percentage recovery and dividing by constant factor, has come into more prominence.

In any case, the record of the well, whether flush, semi-flush, semi-settled or settled, has to be taken into account. Individual judgment based on evaluation of the geological structure, location on the structure, proximity or possibility of offsets, well spacing, gas and water pressure and many other factors have to be taken into account.

Generally speaking, royalties bought on the basis of 3 to 4 barrels of recoverable oil per dollar of investment, as a rough and ready basis of estimate are usually considered to be well-bought. Where the element of uncertainty, so far as operating conditions are concerned, is very low, however, even a basis of two barrels of recoverable oil in the ground per dollar of investment might be justified; or on the other hand, with exceptionally long pay-out period or exceptional uncertainties from the operating point of view, a higher ratio than 4:1 might well be called for.

Transfer order serving notice on pipeline company that royalty payments must be made direct to each and all royalty owners.

STANOLIND CRUDE OIL PURCHASING COMPANY

TRANSFER ORDER

To STANOLIND CRUDE OIL PURCHASING COMPANY, TULSA, OKLA.

INTEREST	TO WHOM SOLD	P. O. ADDRESS
1/88th of 1/8th R.I.	Francis H. Halsey	c/o Empire Trust Company 120 Broadway New York City, N.Y.

WITNESS

SIGNATURE

LANCASTER ROYALTIES, INC.

By John F. Ellis President

ATTEST Secretary

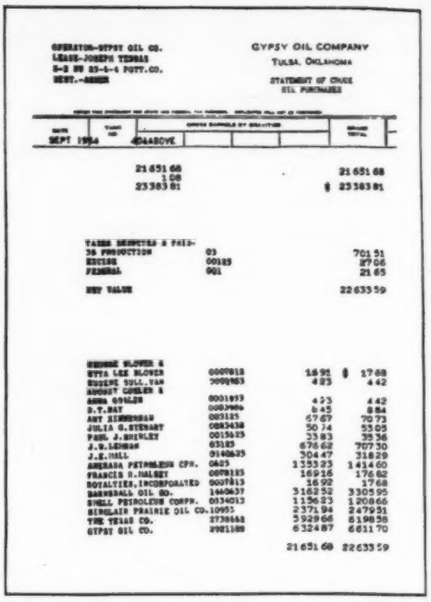
(Francis H. Halsey)

The royalty trusts were organized to take advantage of the appetite of the investment and speculative public for issues of the investment trust type. A horde of new people came into the industry, many of them skilled in selling but ignorant of the oil industry and in many cases, completely devoid of scruples.

With the 1929 crash, in spite of the soundness of the underlying royalties and the benefits of diversification, so many of these inflated structures had collapsed as to throw discredit by the undiscriminating on not only royalty trusts but also royalties themselves.

By 1933-4, a certain revival of interest was noted. Security dealers whose customers closed their ears to offerings of stock were somewhat more receptive to oil royalties and both sound and unsound dealers began to take advantage of the slowly reviving demand.

The creation of the SEC opened a new



GYPSY OIL COMPANY
TULSA, OKLAHOMA
STATEMENT OF CRUDE OIL PURCHASES

DATE				
SEPT 1934	40 ABOVE			
		21651 68		21651 68
		1 08		
		2336381		$ 2336381
TAXES DEDUCTED & PAID- TO PRODUCTION		03		701 51
EXCISE		00123		2706
FEDERAL		001		21 65
NET VALUE				2263359
GEORGE BLOWER & ETTA LEE BLOWER		0007813	1692	$ 1768
EUGENE SOLL. VAN		0000783	423	442
ROBERT GORLEN & ANNA GORLEN		0001953	423	442
R.T.RAY		0002906	845	884
AMY ZIMMERMAN		0003125	6767	7073
JULIA G.STEWART		0003438	5074	5305
PROF. J.BRINKLEY		0003625	3383	3536
J.W.LEMMON		03125	67662	70730
J.E.HALL		0140625	30447	31829
AMERADA PETROLEUM CPN.		0625	135523	141660
FRANCIS H.HALSEY		0078125	16916	17682
ROYALTIES, INCORPORATED		0007813	1692	1768
MARSHALL OIL CO.		1406637	316252	330595
SHELL PETROLEUM CORPN.		0534013	113623	120866
SINCLAIR PRAIRIE OIL CO.		10955	237194	247931
THE TEXAS CO.		2730644	592966	619858
GYPSY OIL CO.		2921189	632487	661170
			21651 68	2263359

Monthly account rendered by pipeline company to all royalty owners which accompanies monthly payment.

However, even a basis of two barrels of recoverable oil in the ground per dollar of investment might be justified; or on the other hand, with exceptionally long pay-out period or exceptional uncertainties from the operating point of view, a higher ratio than 4:1 might well be called for.

The oil royalty business began as an isolated personal transaction between the landowner and the oil producer who leased his land. In the last thirty years or more, it has been developing in the direction of a form of property which is bought and sold, against which loans are made, which is capable of reaching large and small investment capital.

After the Spindletop discovery in 1900 opened up Texas and the mid-continent to oil production, local bankers cautiously began to make loans against production, and to royalty owners against their royalties. From the bankers' point of view these provided an excellent type of collateral, since the monthly check payments made them self-liquidating and their strong legal position gave them high security.

The great increase in interest in oil after the war was reflected in greater investment interest by the east, and by 1926 the new flush fields, Seminole and West Texas, found a growing market for the newly created royalties. The early efforts at proration which followed directly on these discoveries, brought about a sharp clash between the immediate interests of the royalty owners in big quick production and the general interests of the industry as a whole (including the royalty owners) in maximum oil recovery and price stability.

It was at this time, too, that royalty

phase of the business. A new machinery had to be set up, personnel assembled, regulations laid down, and a considerable amount of trial and error was involved. Conflicts with some of the customs and methods in the oil royalty business were inevitable. As late as August 1936, it was reported that 90 percent of the offering sheets filed in the past three months had had to be heavily amended or altogether withdrawn.

However, a modus vivendi seems to have been established as far as SEC regulation is concerned. The main grievances expressed by dealers are that red tape is still excessive and that a settled policy ought to be laid down by the SEC as to publication of estimates of recovery of oil in the ground. Some skepticism is being expressed as to a project reported to be under consideration by the SEC, whereby dealers would have to state a maximum price at which each royalty may be offered.

On the whole, however, the better elements in the trade consider that the SEC has performed a constructive service for the oil royalty business.

This question of price to the ultimate purchaser has become a very serious problem to royalty dealers. A number of factors combined to raise the price higher than it would otherwise be. The farmer-landowner in some cases finds brokers and scouts competing in bidding for shares in his royalty. Payments under the AAA make it easier for him to hold out for a better price. Between the landowner and the eastern investor stand a number of middlemen—the western broker who sells to the eastern wholesaler, who in turn, sells to the eastern

retailer, who finally sells to the investor. At each of these steps, there is necessarily a mark-up. In some cases, a large and prudent buyer equipped to judge values may buy his royalties at cost plus five percent; on the other hand, mark-ups to small buyers completely unfamiliar with the petroleum industry may run to 25 or even 50 percent.

Obviously, when the final price is too high the pay-out period becomes too long and the return on investment too low, tending to narrow the field.

Yet it is estimated that in recent years, over $30,000,000 worth of royalties have been sold in the east and the SEC has registered with it, some 600 oil royalty dealers, perhaps 40 or 50 of whom are active wholesalers.

The former Mid-continent Royalty Owners Association has been reorganized into the National Association of Petroleum Investors to assume national scope. In the east, the Eastern States Association of Dealers in Oil and Gas Interests, Inc. has been formed to maintain higher standards for the royalty business.

The oil industry has gone a long way since the days of President Coolidge and the Federal Oil Conservation Board in the direction of close governmental restriction, first by state authorities and in recent years to an increasing extent by the federal government.

Without describing these measures in detail, they have had a definite effect on the position of oil royalties, particularly from the standpoint of final oil recoveries and of price stabilization. It would be quite wrong to attribute the present tendency to greater percentage recovery of oil in the ground (from an estimated 20-25 percent a dozen years ago to some 35-45 percent now) to proration alone. Technological advances in pressure maintenance, repressuring, water flooding, acid treatment, ever deeper drilling, and on the operating side better well-spacing and unit operation, have all played a very important part, but proration has undoubtedly been a factor. On the other hand, it has made the oil in the ground last longer, taking a longer time to pay out capital investment, and therefore piling up compound discount against present capital values.

The effectiveness of proration in stabilizing price has had no such counterbalancing factor. In the long run, of course, the price of oil over a period of time will be regulated by many factors of which supply is only one, and proration deals primarily and immediately only with supply. Nevertheless the wiping out of the sharpest type of fluctuation in oil prices (East Texas oil as low as 10 cents a barrel in 1931) means that some oil which would otherwise have sold at low prices will under proration command a better price. For the royalty owner this means a better all-over return over a period of time.

In describing the legal status of oil royalties we have indicated one of the strong features in the situation: its basic legal position as an ownership of property rights secured by oil and gas underground. To this may be added the protection afforded by direct payments by the oil purchaser, usually a financially strong concern, and by the triple check of the producing company, the pipeline company and the state tax officials on the amount of oil produced.

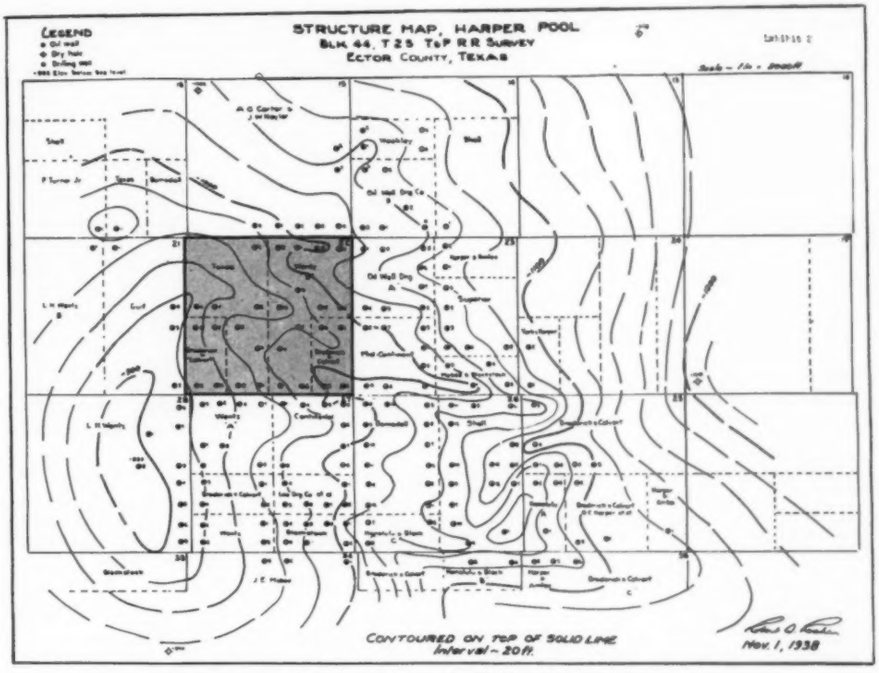
Another strong feature is the pressure of funds for investment, looking around for well-protected securities and also for speculative purchases. The oil royalty business can supply both extremes and anything in between ranging from wild-cat non-producing royalties to well-established interests in production from large reserves under the most advanced type of unit operation and restriction. A number of New York banks have become interested in loans against oil production (as distinct from royalties), and it is worth noting that one of the largest banks in the east has recently organized a petroleum economics department which will presumably safeguard the bank's loans against oil production.

Finally, the well-worn cry of inflation is not by any means dead, and any sharp assertion of inflationary tendencies in government policy would emphasize the commodity character of investment in oil royalties and the close relation of their value to oil prices which would be expected to reflect such inflatory tendencies if they appeared along with commodities as a whole.

From a different point of view, the technological advances of the industry, those resulting in greater percentage recovery mentioned above and such others as geophysical exploration, drilling of multiple sands, and the steady expansion of the industry as a whole, speak well for the long-term future of the oil royalty.

There are however undeniable weak points in the royalty situation as it stands today. The mechanism of regulation, both state and federal, is young and unfinished, liable to sharp unexpected changes. The extent to which proration has had to go in some areas to be effective, cutting allowable production down to five percent or less of potential, has imposed corresponding heavy sacrifices on royalty owners.

The marketing and distributing mechanism has not been functioning to the satisfaction of all concerned for a long time. Sound high-grade dealers often cannot obtain enough good royalties at a price that will be fair to the investor; less scrupulous ones have not been completely driven out, and still are able to function in spite of supervision; many investors are discouraged because of the unwarranted bad reputation which royalties have acquired as a result of the activities of black sheep in the past; a thorough job of selling and popularizing oil royalties has not been accomplished in the non-oil producing regions.


LEGEND
STRUCTURE MAP, HARPER POOL
BLK 44, T 2S T&P R R SURVEY
ECTOR COUNTY, TEXAS
CONTOURED ON TOP OF SOLID LIME
Interval - 20 ft.
Nov. 1, 1938

Map required by the S.E.C. to be filed with the offering sheet.

Early EXPLORATION METHODS

By H. B. Goodrich, Petroleum Geologist

Antielinal Theory and Well Developed Body of Economic Geology as Well as Drilling and Refining Experience Were in Existence Prior to Date When Demand Caused Active Drilling Campaign in Pennsylvania.

From The Bettman Archive

In Athanasius Kircher's travel book on China he expressed his amazement at seeing people bringing their pots and pans of food to hillsides containing burning wells. By merely placing the pot over the hole, the fire (which could not be fed by wood) boiled the meat in a few minutes. There seems reason to believe that this was some manifestation of petroleum.

FOR A PROPER appraisement of the future of oil exploration, there must be a vivid picture, not only of what exists today, but what has gone on before. Libraries and personal experiences are so full of current material that the foreground can be faithfully portrayed. This may depict the trend and application of geological and engineering technique, but when it comes to painting in the background, the oil industry's literary artists should take care not to blur the details of the picture.

The oil industry did not suddenly leap into being solely because of the Drake well of 1859; it came as a natural growth. Since the beginning of history, oil or its derivatives, has had some place in commerce. In the United States there are bookkeeping records of crude oil sales in a small market from 1847 to 1855, while refining was practiced about the latter date. In the Dark Ages of petroleum, chemists and inventors had discovered basic truths and paved the way which led to Colonel Drake's success at Titusville, Pa. From this event were evolved the apparatus and technique of oil exploration, improvements of its exploitation, and finally the industrial set-up as known today.

The summit has not yet been reached. One recalls a remark by a famous scientist; that, contrary to general belief, radio is not a sudden achievement of the last few years but that its history can be traced backward, through contributory discoveries, for about 200 yr. The case of petroleum is parallel.

As far back as 221 B.C. the Chinese were drilling 450 ft. deep for salt.[1] Natural gas from those holes was used to light salt works, and reportedly for domestic and commercial lighting, a long time before the Christian era. Probably methods of drilling wells, and the tools, originated in China, were brought thence to Europe and from there to America. In the United States, well drilling was started by the pioneer Ruffner brothers in 1806, continued through the salines of the Ohio Valley. In 1814 there was a well 475 ft. deep near Marietta, Ohio, and from it oil was stored and marketed on a small scale, albeit at a price per barrel which the producer of today would be glad to get. None of this earlier drilling was intentionally for oil. Among the early settlers in the new country west of the Alleghaney Mountains, there was a steady market for salt. The settlers had drilled holes for brine more than 800 ft. deep, 30 yr. before the Drake discovery of oil at 69½ ft. Indeed probably the deepest of the 74 producing oil wells that had been completed in the Venango, Pennsylvania, oil district in 1860, one year after discovery, was only 502 ft. However, attention is called to two holes which show that elsewhere in the United States relatively deep drilling was not an unknown art prior to the Pennsylvania oil boom.

The first of these was a test for artesian water at the Belcher Sugar Refinery, Saint Louis, Mo. It was begun in 1849 and completed at total depth of 2,193 ft. in 1854[2]. The second example is the Dupont artesian well at Louisville, Kentucky. This began in April, 1857, and finished at 2,086 ft., with a flow of non-potable water in August, 1858.[3] Just a few years ago it was reported that water still issued from the latter hole and was used for medicinal purposes locally.

Operators, practical men, and scientists, interested in the history of drilling technique should read the detailed records of these two deep holes in the ground which were made public at a time when they had real news value. It seems that after 18 mo. had been spent in getting the Belcher well

down 249 ft. by human power, a change was made. From that point steam power was used, the tools being worked by a doctor from the refinery's boiler plant. Some time after the completion of that well, although some oil wells were still being kicked down by man power, steam began to be applied in the drilling of the Pennsylvania oil region.

In 1858, August Beer, an instructor in the Schools of Mines at Pribram, Austria, published the treatise, "Erdbohrkunde." Therein, among other matters, the author discussed principles of the rotary method of drilling. But that is another story. The point is that in the middle of the 19th century, the well driller was coming into his own in the United States, and was ready to go.

Some enthusiasts have asserted that George Washington was not only the first engineer, but should be considered the first petroleum geologist in America. In his diary, under dates November 3rd and 4th, 1770, he gives his notes of survey to cover the 200,000 acres, with the proviso "if we can get it," which had been promised by Governor Dinwiddie, in 1754, to the soldiers enlisted for the French and Indian Wars. Near the mouth of the Kanhawa river he notes "the hills wch. the Indians say is always a fire." He was then looking upon the Burning Springs, W. Va., area which was included in a 250 acre tract of land which was later, July 14th, 1784, patented by Thomas Jefferson, Governor of Virginia, to George Washington and General Andrew Lewis in return for military services. Washington's Will cites the moiety (125 acres) of that tract which had been taken up by Lewis and himself, "for and on account of a bituminous spring which it contains, of so inflammable a nature as to burn as freely as spirits, and is nearly as difficult to extinguish."[4]

In 1783, Samuel Prescott Hildreth was born in Massachusetts. As a young man he moved to Belpré, Ohio, where he practiced as a physician; later going to Marietta. He served a year in the state legislature, but his main interest seems to have been in meteorology, geology, and paleontology. As a leader in science he became a member of the Committee for organization of the First Ohio Geological Survey, in 1836, and served on its corps. He died in 1863. Highly regarded as he was by contemporaries, it is not surprising that his restricted and rather provincial outlook caused him to make some scientific misinterpretations. On the other hand his writings often contain startling, far-sighted hints of practical truths which have become recognized in our generation.

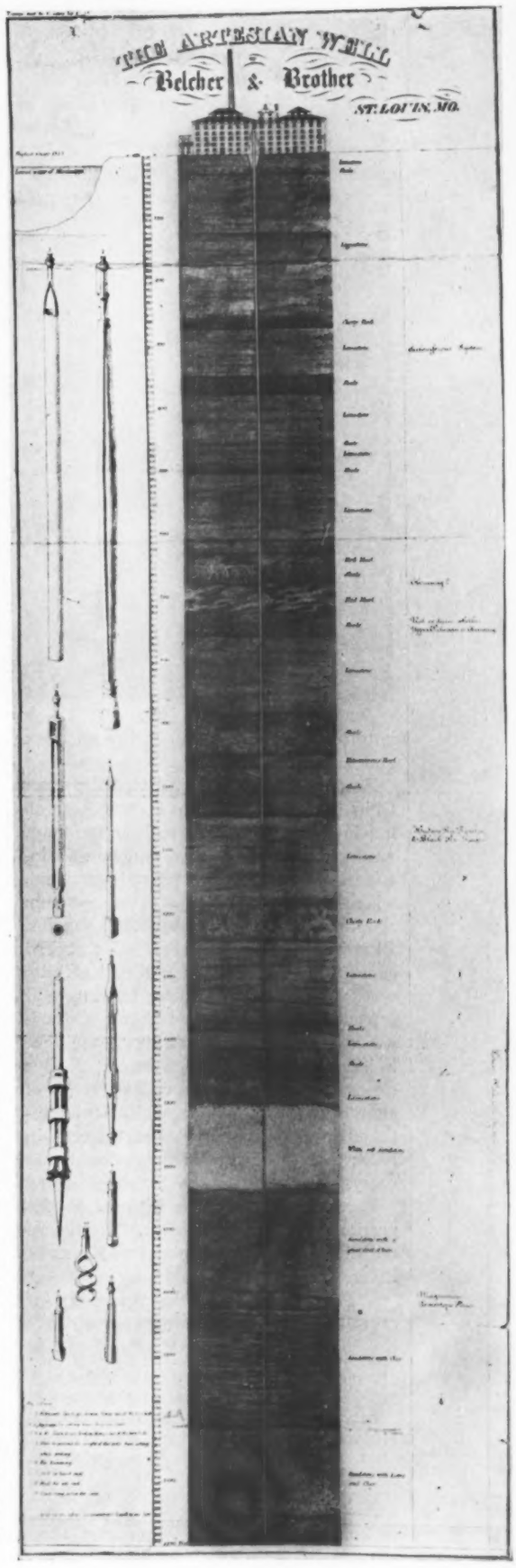
One of Hildreth's reports gives a detailed geological description of an 820 ft. hole, "taken from the original minutes of L. G. Barker, while boring his salt well, in 1831," hear McConnellsville, Ohio.[5] This was one of the precedents in geological procedure, and when the Belcher well came along, scientists made permanent record of its subsurface findings. So we have, not only chemical analyses of the waters, but also collection of drilling samples, their determination and description by famous geologists; all these data published on one of the earliest scaled graphic well logs.[6] On this log, in addition to the conventionalized geologic column, appear marginal illustrations of drills, slips (bits and jars today), and fishing tools. By these pictures with the context it is shown that drillers and geologists were cooperatively active.

Among the latter was J. P. Lesley who is well known to all for the part he played in petroleum geology later on while director of the Second Pennsylvania Geological Survey, and during his commercial career.[7, 8]. As a compiler of well data and oil field operations Lesley's Work was of lasting value. But offsetting his constructive influence in oil history he had a strong prejudice, amounting to an obsession, against the budding anticlinal theory. His unfortunately bitter antagonism to I. C. White's support of that theory retarded an understanding of the relationship of geological structure and oil accumulation, for many years.

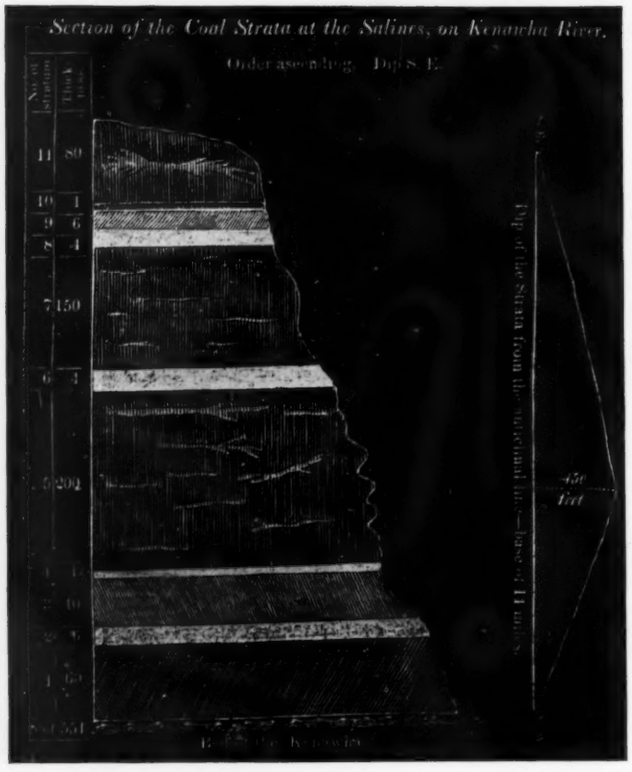
A recent writer has done much to clarify and correct the interesting history of the rise and development of the anticlinal theory.[9] It came about that Dr. I. C. White, of West Virginia, saw its value and applied it to practical commercial use in oil field exploration, but, as he himself stated, he was not the originator of it. Possibly as early as 1840, W. B. Rogers, geologist of Virginia, had noted that rock oil and native gas occurred on anticlines. We cannot find any direct reference to what we call natural gas in his connection.

In his treatise on thermal waters of the Appalachians, which, with tabulated information on about 50 localities, was published about 1842, did definitely show that hot water springs occurred on anticlinal axes or faults. In the same period (about 1842) William E. Logan of the Canadian Geological Survey, described the oil seepages near Gaspé, Quebec, Canada, and located them on anticlines.

These two earlier geologists do not entirely fill in the record. The present an-



The tools used for drilling the Belcher well are pictured with the log on the right: (1) pump; (2) fishmouth, for retrieving lost equipment; (3) apparatus for getting water from any depth; (4) fishing tool; (5) slips; (6) reamer; (7) rock bit; (8) bit for soft rock; (9) connecting screw for rods; (10) fish.



Geological structure drawn by S. P. Hildreth in propounding his anticlinal theory as it appeared in the American Journal of Science, 1st Series, Vol. XXIX, in 1836.

notator would add a still earlier reference and expand a later one.

Attention is again called to the pioneer Ohio geologist, Hildreth, in 1836.[10] As an indefatigable observor and recorder of natural phenomena this worker was intrigued by occurrences of gas and petroleum, which he assumed to have originated from the decomposition of vegetable remains. Elsewhere he mentions that oil that had come from the Kenawha valley had been used as an illuminant after filtering; and somewhat naively opined that petroleum would be used to afford "a clear brisk light in lamps of future cities of the state." This seems to be an independent echo of another writer's opinion which was published in the Pittsburgh, Pa., Gazette, in 1828; that Pittsburgh might profitably use native petroleum for city lighting.

Particular attention is directed to the portion of Hildreth's report, "Section of the Coal Strata at the Salines on Kenawha River," and the following:

"The general dip of the rock strata is toward the N.W. as they approach the Ohio, making those found in the lower part of the hills, above the Elk up the Kenawha, a distance of nine miles up the river, the strata rise at the rate of nearly 50 ft. to the mi. Above this point, to the upper extremity of the salines, the strata dip to the S.E. at an angle somewhat less, or about 33 ft. to the mile, for the distance of six or eight miles; above which point they gradually rise again to the Gauley Mountains. The anticlinal line of the strata being near to the center of the works; the general bearing of the strata being E. and W. and the dip from the line N.W. and S.E. at an angle of three or four degrees.

This arrangement of the strata is of incalculable benefit to the manufacturer of salt, as it brings the riches of the muriatiferous deposits nearer to the surface, and at the same time raises one or two beds of coal, without which the expense of manufacturing would be greatly enhanced."

It is not necessary to comment upon the practical importance of the last paragraph, nor on the fact that he conscientiously worked out a geological structure of which he shows a profile sketch. Even 100 yr. ago that was all in the geologist's day's work. But it is desired to stress that throughout his writings Hildreth had recognized an association of the large flows of oil and gas (which to his mind had some value) with the brine of wells of the region; further that he located the salt and brine on a definite anticlinal structure. Therefore, somewhat indirectly, he infers relationship of oil accumulation to geologic structure. This seems a slightly stronger hint of the anticlinal theory than those of Rogers, and possibly of Logan, made a few years later.

The second event which we wish to em-

Abstract of Points Filed by Judge Wilmot

In His Charge to the Jury, in Case of Gesner vs Cairns, July, 1852
Albert Circuit Court, New Brunswick, Canada

Characteristics	Plaintiff's Evidence	Defendant's Evidence
GEOLOGICAL		
General— Position of the mines and surrounding strata.	An anticlinal axis. A vein, not a bed. An injected mass thrown up. Strata are distorted. No conglomerate above or below. No parallel strata of coal beds. No roof, no floor, no fire clay, no coal fossils, and lies beneath Coal Formation.	No anticlinal axis. Is a bed, not a vein. A deposit, not an injected mass. Strata are parallel. Has a roof, fire clay and coal fossils, and is just where it ought to be in the Coal Series, above Old Red Sandstone, and it would be a miracle if coal were not there.
Special— 1—Internal Structure of the Mine. 2—Structure of the Mineral.	Amorphous. No vegetable structure. No cellular tissue. No lamination. Transmits light.	Has indications of vegetable structure. Distinct laminations. The evidence of its being amorphous is only negative as to a few particles. (See Taylor as to Cuban asphaltum).
MINERALOGICAL		
Density—	Less Specific Gravity than coal. Its Spec. Grav. is 109. Asphaltum 100-120. Coal 120-175.	Some specimens of coal are of less than as given.
Fracture—	Conchoidal.	Many kinds of coal have conchoidal fracture, also flint, glass, etc.
Cleavage—	No cleavage but coal has.	Has distinct lines of cleavage.
Odor—	Like Asphaltum.	Not at all like Asphaltum.
Electricity—	Is negatively electric. Coal not so.	Kentucky coal specimen is electric and some asphaltum is not electric.
Lustre—	Brighter than Coal.	Anthracite coal is as lusterous in some pieces.
Charcoal Dust—	No animal charcoal, which Coal has.	Several pieces of this substance show charcoal.
CHEMICAL		
Fusibility and solubility. Positive. Comparative.	It is fusible—melts by heat and is same after being melted as before. It is soluble in coal tar, turpentine, naphtha, and in other menstrua	Will not melt by heat without changing its character, by throwing off gas. Every known variety of asphaltum melts at not over 250 deg. and afterward can be melted again. Known asphaltums soften in the sun's rays, whereas the sun has no effect on this substance. When apparently dissolved in coal tar, it is not actually dissolved, but only held in mechanical suspension.

Conclusion of the Judge's charge: "While I do not consider it important whether the article be coal or asphaltum, yet so much trouble has been taken on either side in reference to this that I shall ask you to say in your verdict which of the two you consider it."

phasize here, because of its bearing upon the thoughts of early geologists, involves a story about which much was formerly written.[11], [12], [13]. It will only be summarized herein.

Previous to the crude oil development which began at Oil Creek, Penn., in 1859, there had been mined and shipped from the Albert Mines, in New Brunswick, Canada, near the Bay of Fundy, considerable quantities of a peculiar light weight, glassy, black substance. This was later on found to be a hydrocarbon mineral to which the name Albertite was given. From it the Downer Kerosene Oil Company's refineries at Boston, Massachusetts, and other cities, retorted and refined oil which was sold under the name of Portland Oil. Litigation arose as to the title to the Albert Mines property, and this involved the side issue whether the mined product could properly be called coal, or asphaltum. To settle the title a jury trial was held in July, 1852.[14] The list of expert witnesses that appeared and testified on both sides reads like a "Who's Who in Science?" of that day. Among them was Charles Robb, who had examined the Albert Coal in 1849, determining it to be asphaltum. Later (in 1851) in joint report with R. C. Taylor—the chemist—C. M. Wetherill gave it the name Melanasphalt. On the other side Professor Benjamin Silliman, Jr., testified that it was coal and he could see no evidence of anticlinal structure.

At this important historic trial, besides the chemical and mineralogical testimony, there were lectures treating of diverse interpretations of the geological structure of an intensely folded terrain. One of the principal subjects of discussion pro and con was whether the mineral deposit occurred on an anticlinal axis—which idea Silliman and others opposed—an injected asphaltic material in a fissure, or whether it was a bedded coal, with roof, floor, fire clay, and coal fossils; all closely folded.

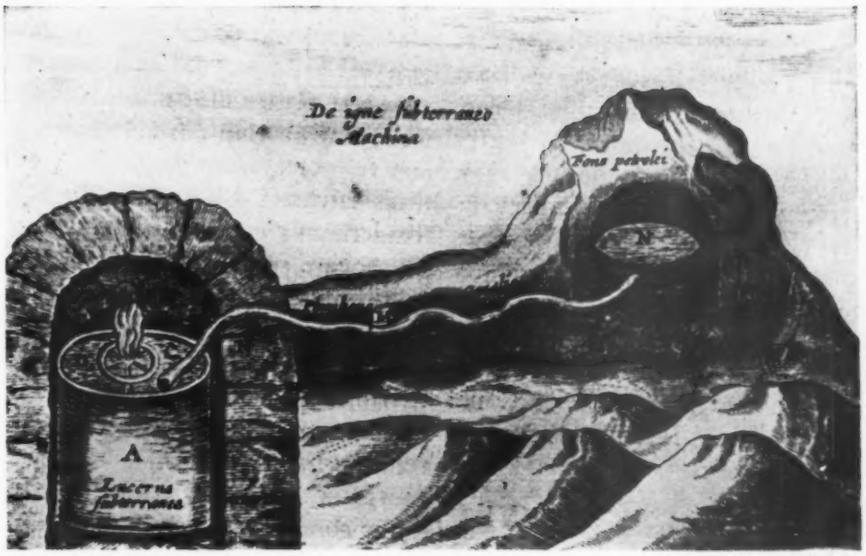
After it had listened to discourses for several days the jury retired for 20 min. and then returned a verdict which included its opinion that the mineral was a true coal. Whatever faith we may have now in the value of expert testimony, or in the jury system, toward settling of geological probblems, we now know that opinion to have been an error.

Because of his own association with it, a sequel to the New Brunswick tale is of special interest to the present writer. Nearly 50 yr. after that verdict, wildcatting for oil, on geology, was undertaken along the Petitcodiac River not far from the Albert Mines. It had been for some time recognized that Albertite was an inspissated petroleum occurring in fissures of uplifted folded rocks. Occurrence of so-called oilite (oil shale) beds and surface structure guided to well location, and drilling resulted in a more or less important discovery of gas and oil about the year 1900. Of more general interest is that in the middle of last century, seven years before the drilling of wells for oil had become popular, some of the scientists of that earlier generation testified to their conclusion that Albert Coal was asphaltum, injected as a vein, a thrown up mass, and that it was associated with an anticlinal axis.

From all the above—first, Hildreth and Rogers in the United States, later Logan in Quebec, and, in the same decade, the law case in near-by New Brunswick it is evident that economic geology was in good standing in pre-Drake well days. Admitting that the media for rapid exchange of professional opinion were comparatively few then, there were both published and unpublished discussions about anticlines that carried oil, gas, or asphalt. Purely academic these may have been, but the anticlinal theory was ready to apply if, or when, found desirable.

Here comes up the question, "How old is petroleum geology?" An author already quoted offers this premise:

"Until petroleum had been shown to



From The Bettman Archive

Athanasius Kircher (1601-1680) was a famous author on engineering subjects and the source of inspiration for this picture. He devised broadcasting systems, air-conditioning, the magic lantern and other modern technical marvels. He was the first to design a pipeline to transport petroleum from its source to the place of consumption, and planned a tank from which a line was run to another tank in which the oil was stored. An asbestos wick swam on the surface of the petroleum with the aid of a cork ring. With this apparatus Kircher held that he had created an eternal light. This 17th century genius considered lead the best material for the pipeline.

The fleet of the Emperor Michael II (820-829) destroying the ships of a rebel through the so-called Byzantine Fire—probably torches dipped in petroleum pitch.

From The Bettman Archive

From The Bettman Archive

Crude oil was placed in these iron or copper vessels and heated until water and lighter oils were evaporated. During the process, the petroleum usually ignited and this dangerous fire had to be extinguished.—De Re Agricola: Distillatio per Descensorium. . 1550.

be of commercial value there was no incentive to search for or exploit it, and speculation concerning its nature and origin was largely academic."[15]

The commercial value of any commodity depends upon its adaptability to human needs. Such writers as S. F. Peckham, Sir Boverton Redwood, and the late David White, in his complete up-to-date treatise[16], have shown that these conditions have existed since the earliest times. Although gasoline was not a part of the life of the ancients, still literature is replete with references to such matters as traffic in mumia, the bitumen used in mummifying; to the primitive exploitation and trade in the rhadinance (oil) of ancient Persia, and its use as illuminant. It is permissible to include natural gas in petroleum problems. In 1821 Fredonia, New York, was lighted by natural gas, the result of accidental discovery, with subsequent intentional development by wells. In the 1830's a writer states that the price of oil at a certain well in Ohio was 50 to 75 c per gal.; he writes that at another locality the supply was sufficient to fill a greater demand than existed. There was always some incentive to recover and possess oil and gas.

The comparatively small requirements of a scattered, adolescent civilization limited the search for petroleum to development of surface seepages, or to the utilization of unintentional (generally undesired) discoveries in salt wells of the United States. Some of the links in an evolutionary chain were: the increasing scarcity of whale oil for use in lamps, the inventions of Young and others applied in refining practice, and incidentally the men who improved the apparatus for lighting and avoiding smoke. In the natural course of events came a desire for more oil, and interest was aroused in the occurrence of oil near Titusville, Penn. This brought about a full report by Benjamin Silliman, Jr., dated April 15th, 1855.[17]

The Pennsylvania Rock Oil Company had been incorporated the previous year. Upon Silliman's recommendations that company was organized and went ahead. The story of the operations and promotional vicissitutes of that company, and its successors, is a classic in the oil business. Perhaps it was mere chance that intervened at a psychological moment, and suggested the idea of drilling a hole (just as had been done to recover salt and artesian water) in order to tap the hidden source of substances whose value had been appreciated for a long time by scientists and business men. Colonel Drake with the assistance of experienced well drillers, brought in the wildcat discovery at Oil Creek.

Returning to the question "How old is petroleum geology?" The answer is that, in some form, it is as old as mankind. Whenever man first saw an oil seepage, a maltha deposit, or found a heavy tarry oil when he dug a well for water; he certainly must have asked what it was, where it came from and how. For instance take some interesting passages from Plutarch's Life of Alexander the Great. In Ecbatana about 330 B.C., Alexander had been surprised at a place where fire issued in a continuous stream out of a cleft in the rock. Not far from this was a naphtha, resembling bitumen, flowing abundantly and forming a sort of lake. For the king's benefit the barbarians put on a spectacular show. Sprinkling the roadway to his lodging with the naphtha, they touched it off with torches and made a causeway of flame. Plutarch then goes on to tell of a practical joke which the soldiers played upon a ludicrously ugly bath attendant who used to sing for the king's entertainment while he was bathing. This man, Stephanus, must have been an easy mark, for he allowed himself to be covered with the naphtha, and then to be ignited; much to Alexander's perplexity and his own painful discomfort. They did manage to save the man's life. The reference ends thus:

"The manner, however, of the production of naphtha admits of a diversity of opinion" (Here the translation states some words have been lost out of the text). . . "or whether the liquid substance that feeds the flames does not rather proceed from a soil that is unctuous and productive of fire as that of the province of Babylon is. . . . "[18]

In that historic era there was a general trend away from the old dogmas which attributed all natural phenomena to certain gods or goddesses. Leaders in philosphy were turning from belief in the supernatural toward the natural. Scientific reasoning was beginning. And so, is it too fantastic to imagine that, if the words missing in the quotation could only be interpolated, we might find that something in the way of a rudimentary geological discussion of an oil occurrence had taken place among those ancient soldiers? The words are sufficient to show that, in the light of knowledge of those days, there was at least some speculation as to its origin.

The conscientious historian must write of men of the past as they saw themselves; he should explain them not on our terms, but on their own. So it is with science. And it is here suggested that if the history of oil geology is worthwhile, a thorough study of

the references to petroleum and natural gas which are to be found from classical, through medieval times and the renaissance, to modern days, will reveal an intensely interesting story of evolution. There were intellects of the past that were trying to interpret the nature and origin of the hydrocarbons. It is believed that, notwithstanding the handicaps of ignorance and superstition and struggling against religious tenets, discussions took place and opinions were advanced that involved principles of geology as well as those of chemistry. One example of the struggle which geology, in common with other sciences had with the accepted religious beliefs is the following:

"... Some drill and bore
The solid earth and from the strata there
Extract a register, from which we learn
That He who made it, and revealed its date
to Moses, was mistaken in its age."

"THE TASK, BOOK VI, THE GARDEN;" by William Coweper, 1785.

Theories to account for the origin of oil naturally took first position. As David White remarks, most of such early hypotheses were based on flimsy circumstantial evidence. One sample of thought is found in "De Re Metallica," by George Bauer (Agricola) in 1544. [19], [20]. That scholarly exponent of the art of mining affirmed a common origin for oil, bitumen and coal—an idea that came on down into late years.

But let us pass on to another subject of geological discussion. Arthur Aikin was born at Warrington, England, in 1773; he died in London, in 1854. Although educated for the Unitarian ministry, he may have been influenced by his association with Dr. Priestly, who was an intellectual iconoclast. On conscientious grounds, he changed over from religion to science as a vocation; was prominent in scientific circles, published much on chemistry and mineralogy, and in 1807 was one of the founders of the Geological Society, London, He was probably its Secretary in 1811, when he contributed the paper of which the following is an excerpt.[21]

"The series is complete at Madeley Colliery where is a pit 729 ft. through beds 86 in number, that compose the formation. The sandstones making part of the first 30 strata are fine grained, micaceous, with plates of coal. The 31st and 32nd strata are coarse grained sandstone entirely penetrated by petroleum. They are both 15½ ft. thick, with a bed of four feet of clay. By certain geologists this reservoir of petroleum has been supposed to be sublimed from beds of coal below, hypothesis not easily reconciled to present appearances, especially as it omits to explain how the petroleum in the upper part of these beds could have passed through the interposed beds so entirely as to leave no trace behind. It is also worthy of note that the nearest bed (of coal) is only six inches thick and

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The famous Colossus of Rhodes was supposed to have guided ships safely to harbor by the torch held in its giant hand; this was probably fed by petroleum.

is separated from the above beds by a mass of clay and sandstone strata without any mixture of petroleum."

Not to mention his assumed origin of oil, here is direct testimony that, more than 125 yr. ago, our predecessors were following the same lines of reasoning for, or against, indigenous or migrated oil accumulations as used today. Those pioneers may not have cashed in commercially on their opinions, but they started some things.

In his "Conquest of Peru," Prescott, referring to the passing away of the civilizations of old, wrote: ". . . but, in science, every stone that has been laid remains as the foundation for another. The coming generation takes up the work where the preceding has left it." The present annotator submits an idea of the evolution of petroleum geology which differs slightly from this and, it is believed, from that of purely contemporary-minded practitioners.

We may picture our science as starting in the mists of ignorance; struggling and winning against obstacles; living, changing, growing, and moving right along with the evolution of civilization. But its advance is not in a straight line, Rather it is on a circling centripetal path, which curves inward and leads in spiral course toward a central point—the truth. Inadequate principles may at times delay the onward march, but finally these are thrown off at a tangent. Only the fit survive, and progress continues. Always approaching the nucleal truth, there are frequent returns along the orbit, apparently to almost the same points touched in previous circuits. So it is that history repeats itself, and the same scientific axioms come to the front through lapse of time; but at each repetition in improved, more usable, form.

As to personalities the Thomas Edisons of the oil industry, and of petroleum geology, will not find their dignity diminished if they will remember that there were Benjamin Franklins whom they, conscientiously or unconsciously emulate. Further, to the extreme modernist it is suggested that the history of the applied science has not yet been fully covered. Fifty years ago Orton, in allusion to oil literature, wrote: "*Multi multa, aliquid omnes, nemo satis.*" That is true today.

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Houston Oil Show

PERSONAL invitations to attend the Oil World Exposition held at the Sam Houston Coliseum from April 24th to 29th were sent to more than 2,000 oil men in all countries where petroleum is produced or refined, with the result that during the week the paid attendance approached 200,000, or considerably higher than that of the last show. $79,140 had been paid for space at the show and more than 70 visitors from at least nine countries outside the United States attended.

A panorama of the most up-to-date equipment and ideas in the various divisions of the petroleum industry were presented to oil men from both the eastern and western hemispheres, while the holding of the exposition in 1939 was extremely advantageous because of the great number of oil men from abroad who came to the United States to attend the other two expositions—the Pacific International Exposition, in San Francisco, and the New York World's Fair of 1939.

Each day special features were scheduled which were of interest both to oil men and the public. The first day's program included opening ceremonies at 2 p.m. on the Coliseum stage with Governor W. Lee O'Daniel, Mayor Oscar F. Holcombe, Col. Ernest Thompson of the Interstate Compact Commission, and John R. Suman, president of the Oil World Exposition and vice-president of Humble Oil and Refining Company, making the principal addresses. Other events of the day included a meeting of the export committee, golf tournaments and skeet shooting matches in the afternoon, and music by the Humble Glee Club in the evening.

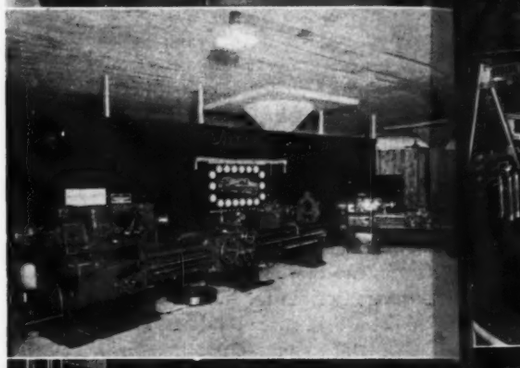
Thos. E. Ward (Oil Field Equipment Co., New York) was master of ceremonies at the export committee meeting. J. R. Aston, traffic manager of Lykes Bros. Steamship Co., presented a paper on "Crating Shipments for Export and Preparing the Necessary Documents"; Robert B. Blaine, of the W. Tucker Blaine marine insurance organization and representatives of Lloyds in Houston, spoke on "Insurance on Foreign Shipments"; T. L. Evans, consul for Argentina, Chile, Guatemala, Haiti and Honduras, discussed "Foreign Exchange"; and Bert Emrick, for many years a pioneer in Far Eastern oil development, spoke on "Methods of Promoting Foreign Sales." "Aviation and Its Place in the Oil Industry" was dealt with by Porter Norris, who has charge of Pan-American Airways operations in the Houston area, while Mihail Pizanty, publisher of the Moniteur du Petrole Roumain at Bucharest, covered "The Petroleum Outlook in Roumania." Another topical paper was that by Tsin-Lon Ouange, vice-consul for China in Houston, on "Petroleum in the Far East," while a special feature was a paper prepared by Paul L. Hopper, of the Fuels Section, Bureau of Domestic and Foreign Commerce, Washington, D. C.

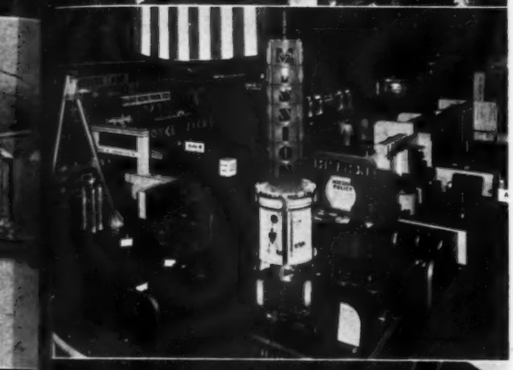
The overseas oil men's banquet held on the evening of the 26th at the Hotel Rice ball room was another highlight of the show. Representatives of companies and governments abroad were reported to be present in unprecedented numbers, and expressed keen interest in new equipment and exhibits.

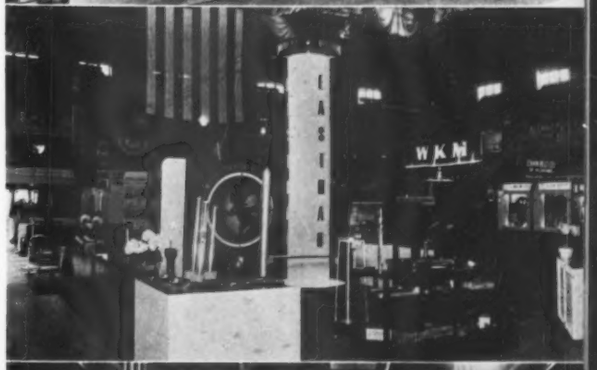
Seven delegates were present from the nationalized Petroleos Mexicanos, including Alfonsa Barnetche, Juan de la Garza Cardenas, Joaquin Castillejos, Donato Estrop, Gutierrez Alfonso, Raul Rodriguez, and Francisco Iguanzo Suarce, all of Mexico City; Excudero Alejandro, Jr., of Vera Cruz; Luis Perez Rossi and Siro Vasquez of Tampico.

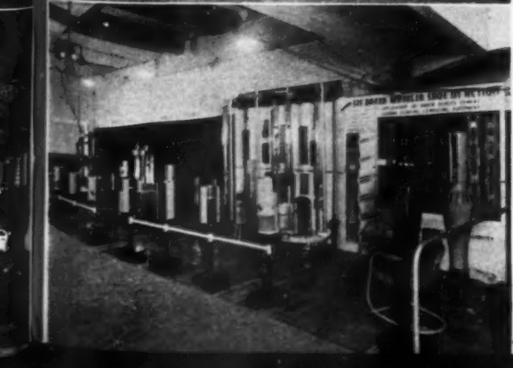
Venezuela was the only other Latin-American country represented, chiefly by officials of American oil companies: B. R. Cunningham and K. T. Daniel of Caribbean Petroleum Company, Maracaibo; H. B. Hegglund and J. H. Regan of Standard Oil Company of Venezuela, Carapito; and A. N. Walp of the Shell interests at Maracaibo.

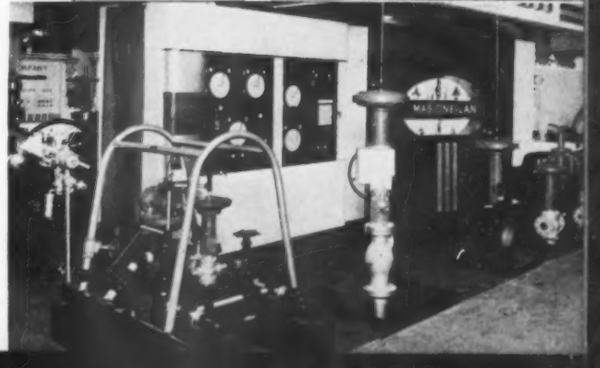
Canada was represented by H. E. Denton, production superintendent for Anglo-Canadian Oil Company, Ltd., Calgary; Walter C. Mueller of the same city; W. L. Peaker, comptroller of Anglo-Canadian Oil Company, also of Calgary; and Kenneth H. Clark, Jr., of the International Nickel Company at Toronto.











Representing Trinidad were A. J. Ruthven Murray, of Kern Oilfields of Trinidad Ltd., and Harry W. Smith, of Trinidad Leaseholds., Ltd. Delegates from England included Giles P. E. Howard and Alexander Ivanoff of Hayward-Tyler, Ltd., London, while C. E. Davis, assistant manager in charge of producing operations for Bahrein Petroleum Company, Ltd., was there from his company's Awali field at Bahrein Is., in the Persian Gulf.

Poland, focal point of the present European discord, was represented by Jakob Schmer, president of the Jakob Schmer Company, Lipinki-Kryg.

Harry Von Rautenkranz, H. Flebbe, and J. Pfeng were there from Celle, Germany, representing the Itag organization.

Trajan Nitescue, field superintendent for the Concordia interests at Gura Ocnitei; P. A. Bouvier, refinery manager at Ploesti, and A. Pamula, field superintendent, of the Columbia organization; and Thomas O'Brien of the Carpatia company, represented Roumania.

The greatest oil show in Houston's history, and the last until 1942, closed its doors on the evening of April 29th.

Immediately after, workmen began the task of removing more than $1,000,000 worth of equipment that oil men from all over the world had come to see at Houston.

The show was one of the most successful ever presented to the industry, and it was estimated that more than $500,000 of oil equipment was sold during the six-day show while potential orders will run considerably higher. This estimate is considered conservative, for many exhibitors are reluctant to announce their actual sales. Jakob Schmer, independent Polish operator purchased a $25,000 drilling rig during the show and announced that if it came up to expectations he would be ordering eight or ten more.

John R. Suman, president of the Oil World Exposition, asserted that he had conferred with Wm. Skelly, president of Tulsa's oil show, regarding the holding of shows in each of the two cities at two-year alternating periods and quoted him as replying that Tulsa would do what the equipment industry wanted.

Photos by Louis Tucker

Chemical Construction Corp. contact sulphuric acid plant of Trinidad Leaseholds Ltd. at Pointe-á-Pierre.

Foster Wheeler topping plant at the Pointe-á-Pierre refinery of Trinidad Leaseholds Ltd.

Adequate illumination ensures a maximum of efficiency and a minimum of accidents during night operations.

Photo by Louis Tucker

TRINIDAD LEASEHOLDS

Modernize Pointe-a-Pierre Refinery

Trinidad Refinery Handles 65 Percent of Island's Production—New Cracking Unit and Iso-octane Plant Prominent Features.

THE VISITOR to the tropical island of Trinidad soon finds his way south along the west coast of the island to see the famous Pitch Lake. One sugar plantation after another is passed, when with surprising suddenness a gleaming city of aluminum comes into view, strikingly contrasted with its background of coconut palms. This is the refinery of Trinidad Leaseholds, Ltd., at Pointe-a-Pierre.

Trinidad Leaseholds have just completed their 25th year in Trinidad as a producing and refining company, and the success of their operations may be gauged by the fact that in the last two years they have carried out an extensive program of refinery extension and improvement. As Trinidad's crude oil output, which amounted to approximately 17,500,000 bbl. in 1938, is the largest individual production within the British Empire, and as 65 percent of this crude is refined by Trinidad Leaseholds, the Pointe-a-Pierre refinery occupies a particularly important place in the oil affairs of the Empire.

A large increase in cracking capacity, modernization of existing processes, and the addition of plants for the manufacture of special products such as iso-octane, and Diesel oil of high ignition quality, are the main features of the new refining plant. Although the crude topping capacity has not been increased, the refinery is considerably more flexible than before.

DISTILLATION

Trinidad Leaseholds are currently processing more than 30,000 bbl. crude oil per day, of which 50 percent is their own production and the remainder purchased from other producers. This crude is moved to the refinery from the main producing area in the south-west portion of the island, a distance of 17 miles, through a 10-in. and an 8-in. pipeline. In addition, more than 2,000 bbl. per day of Leaseholds' own production is pumped 30 miles from the Guayaguayare Field, in the south-east, together with production from their Barrackpore Field in the center of the island.

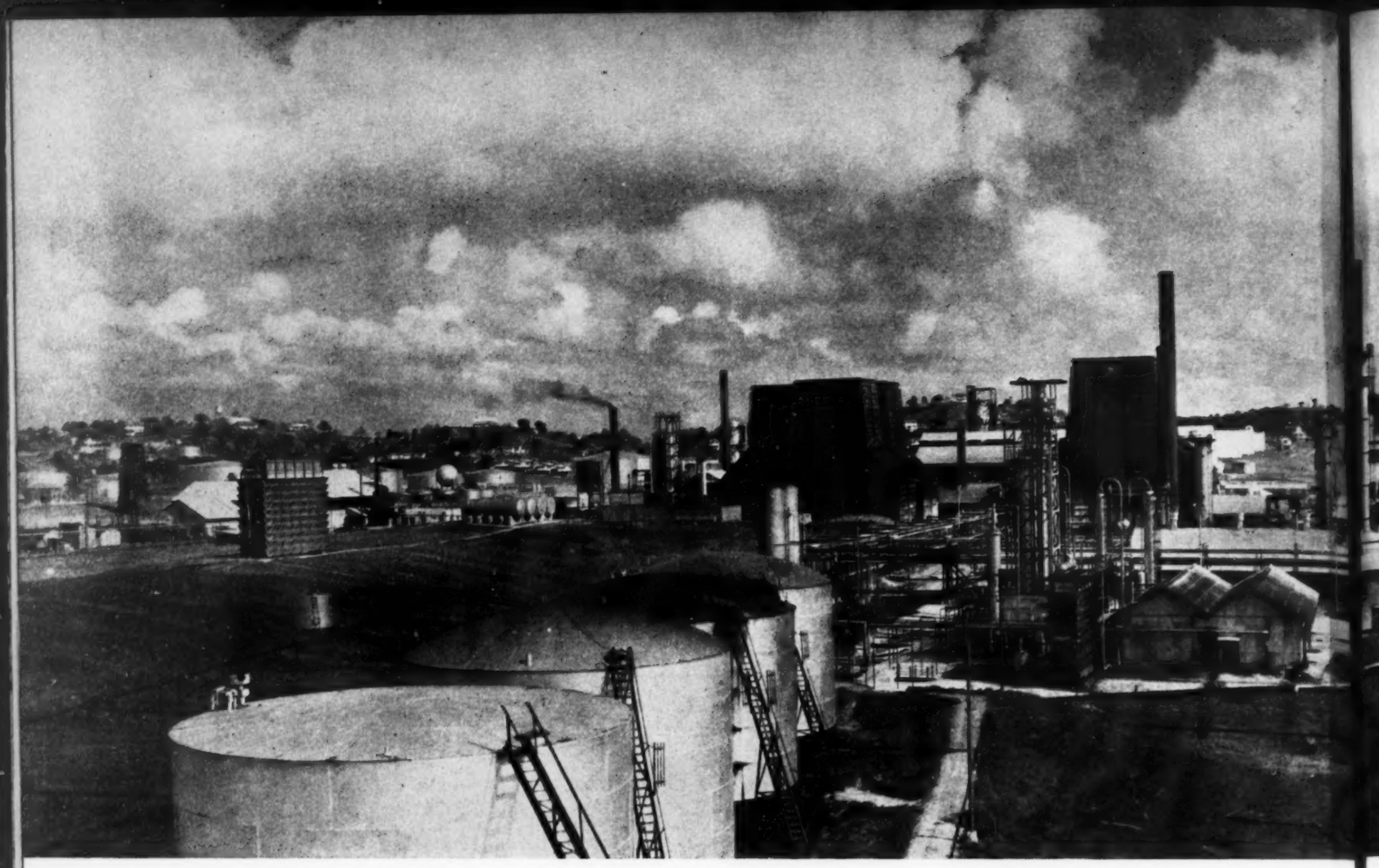
Trinidad crude oils are in general relatively high in octane number, and for the manufacture of aviation spirit at Point-a-Pierre, the higher grade crudes are segregated in the field and moved in separate batches through the pipelines. Accordingly three main types of crude oil are processed at the topping plants: aviation type crude, average Trinidad crude, and Guayaguayare crude. From all of these specific products are made, so that special arrangements are necessary for their segregation and storage.

There are three topping plants, one of Alco and two of Foster Wheeler design with a combined capacity of 30,000 bbl. per day. Formerly, the pressure distillate production of the cracking units was rerun by refluxing at one of the topping plants and in May, 1938, a new pressure distillate rerunning plant of Foster Wheeler design was put into service. This is a low-temperature two-stage atmospheric and vacuum rerun unit of 6,000 bbl. per day capacity. The highest temperature to which the pressure distillate is subjected is 300 deg. F., and as it is separated into 90-95 percent distillate and 5-10 percent bottoms, flushing gas oil is injected into the vacuum tower.

Included in the topping plant battery is a small straight-run gasoline debutanizing unit, for rerunning aviation spirit base stock to meet vapor pressure specifications, and for producing the high volatility gasoline required for blending with iso-octane to make 100 octane spirit.

CRACKING

The new cracking plant, which has cost $1,500,000, and which was put into operation in June, 1938, has fractionation and stabilization equipment designed to handle the pressure distillate production of the two existing cracking units, so that the whole forms an integrated system. The total fuel oil cracking capacity of the three heavy oil furnaces is 10,000 bbl. per day and the reforming



furnace handles 3,600 bbl. per day. The light oil furnace, which cracks a sidecut from the fractionator, has a capacity of 7,000 bbl. per day.

The endpoint pressure distillate from the fractionator is further fractionated in a secondary tower into a heavy cut and a light cut, which is then depropanized and debutanized. Both of these cuts are acid treated directly from the cracking plant. Extremely close control is necessary in the debutanizer stage, for maximum recovery of butane-butene fractions, which form the charging stock for the iso-octane plant. The soda treatment necessary for removal of sulphur from the butane-butene fractions is applied in two stages. Fresh soda is used to wash the debutanizer tops and the soda from the debutanizer stage is then used to wash the depropanizer bottoms, the soda from the latter stage being recovered in the adjoining soda regeneration plant.

A special point of interest in this cracking installation is that for flexibility auxiliary equipment has been provided for the vacuum flashing of residuum to petroleum pitch. If necessary, this section of the plant could reduce to pitch the entire residuum production of the cracking plants.

As a result of the increased cracking capacity, a larger P.D. treating plant was required. The new plant, designed by Trinidad Leaseholds, handles the light and heavy pressure distillate cuts through separate sections and includes a complete treating unit as a spare for either service. Acid of 63 deg. B. is used, and the light P.D. fraction is given a relatively smaller treat.

For acid manufacture, a Chemical Construction Corporation sludge conversion and sulphur burning plant was built in 1937 and put into commission at the end of the year. This unit, which replaced a Kestner vacuum concentration plant, can operate on acid sludge and sulphur together, or on either alone, and is capable of producing 20 tons of 66 deg. B. acid per day. When the Kestner plant was in use, it was necessary to import oleum from Europe, to fortify the recovered acid. Operation of the new contact plant has now cut acid treating costs in half.

As the unit can furnish a large supply of purified SO_2 gas, it is also used to provide liquid SO_2 make-up for the Edeleanu plant.

ISO-OCTANE

The Pointe-a-Pierre iso-octane plant is of particular interest to oil refiners in that it is the first commercial installation to employ low pressure hydrogenation of the C_8 polymer produced by phosphoric acid polymerization of butane-butene fractions. The plant consists essentially of an assembly of three polymerization reactors, debutanizer, rerunning column for separation of polymer into dimer—the C_8 fraction, and trimer—the C_{12} fraction, with two nickel catalyst hydrogenation reactors for conversion of the dimer to finished iso-octane. The hydrogen required for the process is furnished by the adjoining hydrogen plant which produces hydrogen through the reduction of steam by metallic iron.

The octane number of the finished iso-octane is chiefly determined by the intensity of the polymerization in the first stage of the process. When the first hydrogenation reactor will no longer hydrogenate, it is still extremely effective in sulphur removal, and the reactor can then act as a guard tube, increasing the life of the nickel catalyst in the other reactors.

The Pointe-a-Pierre iso-octane plant was started up at the same time as the new cracking plant was put into commission and is in regular and satisfactory operation.

With regard to other plants, the refinery is equipped with an Edeleanu plant for the manufacture of high grade kerosene from raw kerosene processed from selected crude. The plant has a capacity of 45 tons raw kerosene per day and from time to time it is used for treating gas oil to make high aniline point Diesel oil.

As Trinidad Leaseholds' requirements of the latter are increasing, a Diesel oil plant using The Texas Company's furfural ex-

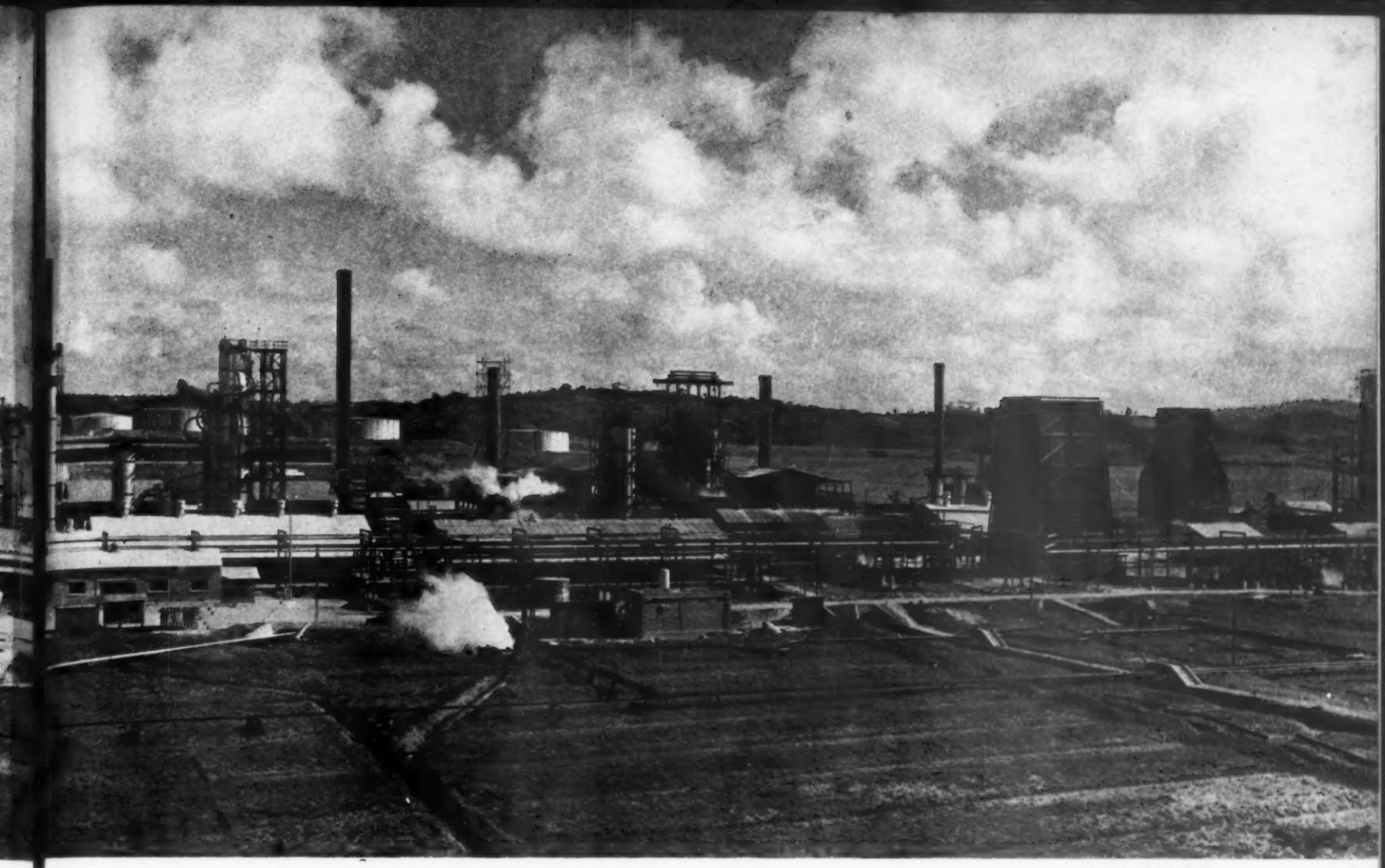


Photo by Louis Tucker

traction process is now under construction. This unit, which has been designed to produce 220 tons of refined Diesel oil per day, is the final item of the present plant construction program and its operation is due to commence towards the middle of 1939. Part of the furfural required for the operation of the plant is being prepared at the refinery, from megasse, by-product of the surrounding sugar refineries.

UTILITIES

Production of steam, electric power and compressed air for the Point-a-Pierre refinery is centralized in the power station which is located approximately at the load center.

The steam plant, which is augmented by Foster Wheeler waste heat boiler installations on two of the cracking plant furnaces, consists of three boilers with a total evaporation of 105,000 lb. of steam per hour at 225 lb. per sq. in. and 550 to 600 deg. F., a Stirling boiler and one Foster Wheeler boiler with a total evaporation of 100,000 lb. per hour at 475 lb. per sq. in. and 700 to 750 deg. F.

Steam is supplied throughout the refinery at 175 lb. per sq. in. with smaller systems supplying steam at 475 lb. per sq. in. and 25 lb. per sq. in. Refinery power and process consumption amounts to 60 percent of the normal steam demand of 130,000-150,000 lb. per hr., the remaining 40 percent being used for electric generation.

Electric generation is at 2300 volts three phase 60 cycles, the generating plant consisting of two 1500 KW. direct-coupled pass out turbo-alternators running at 3600 r.p.m., operating on steam at 225 lb. per sq. in. and bleeding at 25 lb. per sq. in., together with a 1500 KW. geared pass out turbo-alternator running at 6000/1200 r.p.m., bleeding at 175 lb. per sq. in. and 25 lb. per sq. in. and a 3500 KW. full condensing geared turbo-alternator running at 6000/1200 r.p.m., operating on 475 lb. per sq. in. steam.

Fresh water supply is provided by a system of three dams, the annual rainfall being from 50 to 90 in. with an average of about 60 in. Salt water for certain plants is also used, particularly during the first five months of the year, which are relatively dry. In all there are 13 natural draught timber construction cooling towers, of maximum total capacity 130,000 U.S. gallons per minute.

PRODUCTS

Total storage at Pointe-a-Pierre amounts to over 2,000,000 bbl., of which 600,000 bbl. is crude oil storage, 750,000 bbl. gasoline, pressure distillate and aviation spirits, and the remainder fuel oil. As the number of different products shipped from the refinery has greatly increased, an entirely new ocean pipeline viaduct one mile long is now being constructed at a cost of a quarter of a million dollars.

The bulk of the refinery's products, comprising a specification fuel oil for the British Admiralty, two grades of high octane motor fuel, various grades of aviation spirit, and distillate Diesel oils, are shipped to Great Britain where the gasolines are marketed under various grades of Regent Petrol. Three new tankers are employed in this service, each of approximately 115,000 bbl. capacity, and making regular two-week voyages between Trinidad and the United Kingdom. These are the REGENT TIGER, REGENT PANTHER, and REGENT LION.

Another new vessel, the S.S. LA CARRIERE of 55,000 bbl. capacity, commissioned in 1938, is used for supply of fuel oil, gasoline and kerosene to Jamaica and the other islands of the West Indies.

The petroleum requirements of the West Indian islands themselves are relatively small but through Trinidad's geographical position between the North and South Americas there is a substantial bunkering business, vessels being supplied both at Pointe-a-Pierre and in Port-of-Spain. During the cruise season from January to March, many well-known passenger vessels

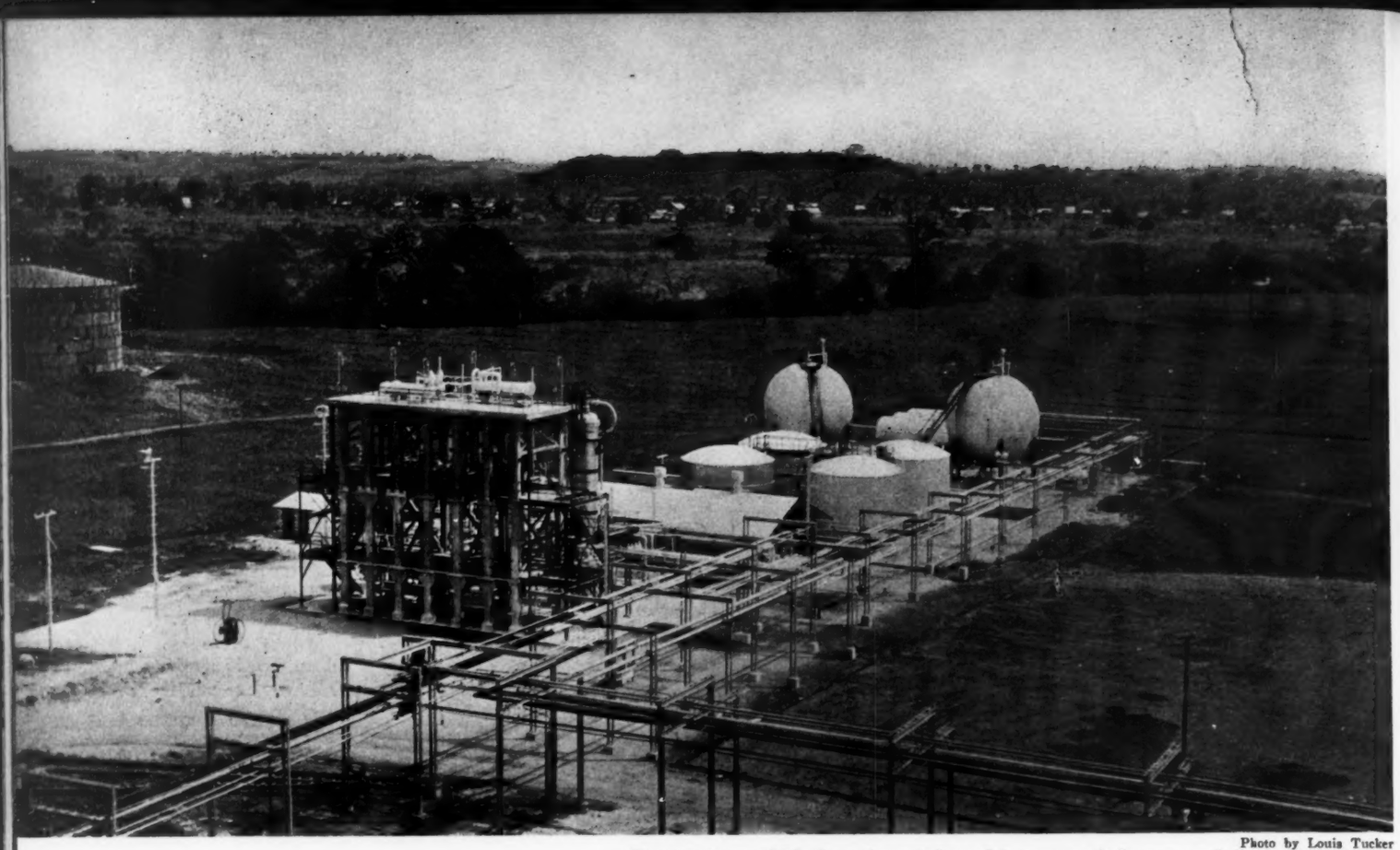


Photo by Louis Tucker

The terrain on which the refinery is located is comparatively open and flat—polymerization and hydrogenation units at Pointe-a-Pierre.

Part of Trinidad Leaseholds' Pointe-a-Pierre refinery showing the cracking and reforming plants and fractionating towers. Photo by Louis Tucker

such as the NORMANDIE, AQUITANIA, and BREMEN are visitors to Trinidad waters, and in December, 1938, a local bunkering record was established when the AQUITANIA was supplied with 7,000 tons of fuel oil at a rate of 1,400 tons per hour.

ADMINISTRATION

As part of the program of expansion, the company is erecting a modern air conditioned administration building together with a large central building for the housing of refinery stores. The island is so far from the sources of supply that relatively large inventories of spares and chemicals have to be kept, and special measures taken for their protection.

There has naturally been a large increase in staff, for whose accommodation attractive tropical bungalows have been built in the residential area overlooking the refinery, and for whose medical care a new air conditioned hospital is being erected.

Although only 10 deg. from the Equator, Trinidad has a remarkably mild climate which permits sport of all kinds. The importance of staff recreation has always been well recognized by Trinidad Leaseholds, and there are excellent facilities for tennis, squash, soccer, rugger, cricket and sea bathing. Acres of coconut palms were cleared to make a nine-hole golf course which now ranks as one of the finest in the island.

W. P. Staff Photo

C. E. Davis, at his company's offices in the Chrysler Bldg.

C. A. Neusbaum in his cabin on the Santa Rosa.

Foreign Oil Legion

C. E. DAVIS, assistant manager in charge of producing operations for Bahrein Petroleum Company, Ltd., at Awali, passed through New York April 20th to 22nd, en route to the Houston Oil Show. He had flown by plane from Bahrein Island to London, and after spending a few days in England proceeded to the United States. Mr. Davis is on six months leave in America and after the oil show will be making a trip through the Texas and Oklahoma oilfields studying the latest production technique prior to taking a look at Kettleman Hills and settling down in California.

DR. E. OSPINA-RACINES, formerly first vice-consul in charge of petroleum affairs in New York for the Colombian Government, sailed for Bogota May 12th on the SANTA CLARA accompanied by his wife and daughters. Dr. Ospina will reside in Bogota and will assume the position of engineer in the petroleum department of the Ministry of Economy. The post of first vice-consul in charge of petroleum affairs in New York is now being filled by DR. E. GAMBA-ESCALLON, formerly of the petroleum department in Bogota. Dr. Gamba arrived in New York on April 4th, having made the trip on the SANTA MARIA.

C. A. NEUSBAUM, assistant director of the standard inspection laboratory of Standard Oil Development Company, sailed from New York May 5th on board the SANTA ROSA en route to Curacao. From Curacao he took a plane to Aruba where he is to spend about three weeks at Jersey Standard's refinery at San Nicolas. At the time of his departure Mr. Neusbaum was undecided whether to return to the United States by air or on board the ESSO NEW ORLEANS, which tanker was built by Jersey Standard in conjunction with the U.S. Maritime Commission and makes the former eight day trip in 100 hours.

W. P. Staff Photo

T. D. PEACE, genial liaison officer of Shell Union Oil Company, left New York early in April to return to England after 11 years residence in the United States. For several years past he had devoted a considerable time to his company's labor relations and was prominent in arranging for pensions and other employee benefits. Mr. Peace has now established himself in the London offices of the Royal Dutch-Shell: his work in New York has been taken over by H. N. ENGLANDER.

BRIAN P. MEAD, chief engineer of the Port Jerome refinery of Standard-Franco-Americaine de Raffinage S.A., arrived in New York on board the NORMANDIE May 1st with Mrs. Mead and their three children. They will remain in the United States for several months.

W. P. Staff Photo

Dr. Ospina, right, former Colombian vice-consul in charge of petroleum affairs in New York, with Dr. Gamba who now assumes this post.

C. Clay Johnson, who recently completed a nine-month trip throughout South America for Shaffer Tool Works, standing beside the sunken garden at Radio City, New York, where he has just established offices in the R.C.A. Bldg.

W. P. Staff Photo

DOODLE-BUGS Don't Get Rich

By Wm. B. Sherrill

DOODLE-BUG men—variously known as doodlers; doodle-buggers; nuts; and other less complimentary appelations—can be found in (and out) of every oilfield in the United States. They may have been wealthy at one time, (a few of them are, today). They may be rich beyond their wildest dreams if and when their moment arrives. The moment for which they work and hope and pray and scheme and starve: The moment when a driller who has contracted with them, brings in a 10,000 bbl. gusher after having built his rig exactly over the spot where Mr. Doodle-bugger drove his peg and sententiously announced, "Two thousand feet — straight down, mister."

Doodle-bugging belongs in the realm of mysticism; of supernatural forces.

Doodle-bug men wander over the earth's surface wherever they may be, following the queer, superstition laden thing known as a doodle-bug.

"Here," they say in confident, unexcited voice, "is oil."

The location of the exact spot where the drill bit shall bite the earth isn't the full extent of their professed knowledge. The doodle-bug man then tells you how far down it is to the first oil bearing stratum—and the second—and the third—in unequivocal tones he declares that the production from that well will be in excess of a certain number of barrels.

Is the doodle-bug an accurate and reliable oil finding medium? There's many a yarn that at least two major companies and an unknown number of independent producers believe in a doodle-bug man.

Then there's the other side—and from the ranks of the doodlers, themselves, we quote verbatim, the opinion held by one man who has followed the nodding nose of his oil locater for "a half-a-million miles!"

"This scoundrel," pointing to his own instrument, "fooled me once. I was working in Brazos county (Texas) and found a lot of oil near the Navasota river. I was mighty pleased with it and that night I got hold of a man who had promised to drill on my next location. So the next day I took him out to the river to show him what I'd found. Well, sir, do you know that I couldn't pick up a trace of oil on the same spots that I'd been over the day before! I walked back and forth—back and forth—and all I could get was a signal from the right; the blamed bug kept nodding to the right. Well, I follered her to the right, clear down into a little ole creek bed that dipped into the river and there she started dipping. She found that there oil pool again even though it wasn't in the same place as the day before."

MOONSHINE

"I felt disappointed—and mad, too—because my man who had promised to drill, got disgusted when I had to change my location on him and he told me he was through follerin' the damn doodle-bugs. 'Course, I didn't exactly blame him; it did look bad and it had me fooled until several nights later when I got to studying about it and figgered out the right answer. I remembered that the first day there'd been a strong north wind and, knowing that wells always flow more in the light o' the moon than in the dark, I got to thinking about the water pressure. Then I remembered of water wells going dry whilst a stiff norther was a-blowin' and I realized just what had happened. All pools are forced into and held in their present positions by salt water pressure, you know, so I just figgered it out that the water pressure on the north side of that pool had become so strong that it forced the oil out of its natural position and up into the flats where I had found it on the windy day; after the wind died down, the water pressure became normal and the oil came back to its normal—that is, its regular place in the pool where I found it on the next day."

Yet another story that every one of these men of mystery blithely disregards, is the one concerning a major oil company located in Houston, Texas. It is generally understood that this concern keeps a large can of oil (crude oil from a well) concealed on, or between, one of the three floors occupied by the research department. From time to time, so the story goes, doodlers—filled with a sincere conviction that they have, at long last, perfected the perfect oil locating machine—approach the chief of the department. They are all cordially invited to find that can of crude oil—The invitation is still open.

Perhaps the most popular type is the so-called forked stick doodle-bug. It derives from the centuries old water-witch which was nothing but a forked willow stick, not too large to make it unflexible, and in the shape of a Y with the prongs being about 12 in. long and the shank about eight inches in length. The legend and practice is

A veteran of 20 years doodling experience stoops, quiets the movement of his single stick doodle-bug, and then counts the dips it makes; note the saddle-grip hold he employs. In doodling he had deliberately turned his back on the nearby producing well to obviate the pull from it.

that the operator walks over the ground holding the doodle-bug's forks in each hand. When he crosses over water, a strange force turns the shank of the doodle-bug downwards.

With a single addition, declare those doodlers who use them, the forked stick doodle-bug will find oil beneath the earth's surface. This addition is the owner's secret and is—to outward appearances—a container approximately three inches long and one and one-half inches in diameter. Sometimes these containers are made of wood, sometimes of leather, occasionally of a fine chamois skin, which is filled with some substance: commonly supposed to be crude oil from the nearest producing well to the territory under exploration.

Owners of this type of doodle-bug state that they determine the depth to the oil by the strength of the pull on their hands by their doodle-bug. A violent, strong pull that bends the end of the shank straight down, indicates that oil is not deep—perhaps less than 1,000 ft.—not more than 1,500 ft. under the earth's surface. By the same token, a weak pull that, apparently, has difficulty in bending the bug clear down, means that the oil pool underneath is 4,000 or 5,000 feet down—perhaps as much as 8,000 ft. deep.

EAST TEXAS

A prominent ex-doodler (ex because he has made a sizable fortune and succeeded in taking it with him when he left the oil game) who used the forked stick type of doodle-bug, was questioned about the

famed East Texas Field: Did he know for sure whether or not Etex was discovered by a doodle-bug operator?

"Well, I don't know," he drawled, "Don't know whether you could rightly say that a doodle-bugger discovered any part of the five counties that go to make up the East Texas field; you know it's in the neighborhood of 75 mi. long an' that's a right smart distance—specially if you go to steerin' a bug over it," he sighed and leaned back wearily, as if he, himself, had just finished tramping that right smart distance. "All I know is that I worked all over that part of the state years before Dad Joiner brought in his first well over there and I found indications of so dadgummed much oil that I just up and decided that my dog-gone 'bug' had went and gone clean crazy. I never did tell a soul for fear that I'd be laughed clear outa the country."

The electric doodle-bug—a type owned and operated by comparatively few doodlers—is similiar to the forked stick type in every respect with the exception that the mysterious medium attached to the end of the shank is heavily covered with ordinary friction tape from which emerges two electric conduit wires. They are directly connected to two dry cell (telephone) batteries which, ordinarily, are carried in the operator's pockets, or—if prospecting in a car—are placed in a battery box resting on the floor of the automobile.

This contrivance, like the forked stick doodle-bug, shows the presence of oil when the operator passes over it, by bending its shank downward. It will not, however, determine the depth to the oil pool unless the wires are properly connected to the batteries. The doodler locates his pool in the customary manner, then has an assistant hold the wires and stand by for instructions. The operator then grasps his doodle-bug firmly in each hand and holds it in an upright position. When all is in readiness, he calls "Contact"—the assistant touches the wires to the proper battery terminals—the shank of the doodle-bug starts dipping back and forth towards earth and the operator starts his count with an intonation and rhythm much like that of a referee in the squared circle when he is counting over a knocked out boxer. But the doodler's count is for each 100 ft.: thus a count of 12 signifies 1,200 ft. to the oil.

DIVINE POWER

Most doodle-buggers believe that there is a divine power within them that makes their doodle-bug work for them while it won't work for others. A user of the electric doodle-bug referred to this belief in relating an incident wherein he had successfully predicted a new oilfield.

The electric doodle-bug in actual use by a devotee of that type of oil locater. He follows little-traveled byways in his old Model T and frequently spots locations directly under the road he travels. The bug is attached by wires to the battery box behind him.

"I knew of a hot spot out in Guadalupe county several years ago," he said, "And when I got out there to prospect around, I found a whale of a big pool only 2,300 ft. down. I looked up the old lady that owned the acreage it was under and told her that when a well was put down there they'd drill not more than 2,320 ft. and bring in not less than a 9,000 bbl. well. Of course, she laughed at that and invited me to stay and have dinner—which I did 'cause groceries was getting kinda low. About a year later, they did drill on the old lady's land and blew in a well with a 9,500 bbl. potential. I dropped in to see the old girl who was a grand lady. She asked me how I could tell about oil like I did. I told her, 'Lady, it took me 21 years to realize that I was tuned in with the vibrations that are constantly circulating between heaven and earth and if God's spirit moved in you in the same way, I could learn you in ten seconds how to hold this doodle-bug's horns. But, you're like most everybody else: you aint in tune with the Infinite so it wouldn't do no good to learn you the simple operation of a doodle-bug.'"

The second type is best described as the single stick doodle-bug. It is a willow stick about 30 in. in length and not over three-fourths of an inch in diameter, to one end of which is attached the doodler's packet of some mysterious substance. Many users of this style of doodle-bug profess to find oil, gas or a salt dome beneath the earth's surface and have three different bugs to use depending upon what they are looking for.

In using this doodle-bug, the operator holds it, saddle-fashion, between his two hands and directly in front of him. Then he walks or rides over the suspected territory and watches for an indication from his oil locater. The end of the stick with the bug on it will start pulling or waving gently towards an oil pool as far as several miles to the right or left. When the direction has thus been established, the doodler moves over by degrees until he is within a hundred yards or so of the pool when the doodle-bug will commence a vigorous waving. When directly over oil (or gas) the contraption starts a positive up and down bobbing, easily recognizable.

The operator stops; stills the movement of his bug with one hand, then waits a few seconds for it to start again. By counting the bobs he determines the depth to oil: each bob representing 100 ft. If an oil pool is located 2,000 ft. down, for example; another pool 1,800 ft. below that and yet another pool 1,000 ft. below the second, the doodle-bug will bob 20 times, start swinging from right to left, become momentarily dormant, bob another 18 times, swing from right to left again, become still, then bob 10 times more and start swinging from left to right.

Doodle-bug operators are jealous of their machines and regard all others as being far beneath their own contrivances in efficiency and reliability. An instance of this is found in the experience of a single stick doodler. An acquaintance of his—a Greek restaurant man who had become greatly interested in the rotary or gyrating type of doodle-bug—had backed his firm belief in the efficiency of his newly discovered oil locater with plenty of hard cash; cash that represented his life's savings plus what monies he could persuade his friends to put up. With a part of this operating fund he drilled a hole 1,600 ft. down from the spot where his gyrating bug had swung in a perfect circle and found nothing even remotely resenbling oil or gas. His faith in the doodle-bug was reflected in the light in his black eyes—a light shining steadfast through all the disappointment.

The forked stick doodle-bug being used by a former oilfield newspaper man who took up doodling. He was approximately three-quarters of a mile from a proven field and declared that a finger from the mother pool extended along the 50-ft. strip on which he stood.

The gyrating doodle-bug was brought into action again and another location—some 100 feet in a straight line below the duster—was spotted. Another driller came on the job and another 1,600 ft. of expensive hole was shoved down and all the cash used up and still they had no oil.

The Greek restaurateur turned oil promoter was standing by the second deep disappointment with his small circle of not-so-friendly friends, watching the driller as he methodically went about the process of moving his rig off of the location. A forlorn bunch were they and not very interested in a ramshackle Model T that came bumping and coughing over the stubble field from the near-by highway.

"Hi, there, Steve, how's the oil well?" questioned a wrinkled and greying man, flushed of face and perspiring freely, as he leaned out of the coupe's window.

"Oh, hello, Frank," answered Steve, the Greek, "Well, I don't know, it look to me like something, she go wrong again. My doodle-bug say that oil sure be here but, by golly, we didn't get her. Maybe so we didn't go deep enough, heh, what you think?"

Frank climbed out of his Ford and walked stiffly over to the group. Producing his own doodle-bug—one of the single stick variety—he turned on his heel and walked towards a rise on the left. When he was on it, he unlimbered his equipment and started doodling. With a little moving back and forth, he soon reached a spot where his bug started dipping regularly to earth. Calmly he counted the bobs.

"You go down 1,550 ft. from here and you'll get 1,000 bbl. a day," he pronounced in a tone that brooked no disputation.

"Now come over to that other little high and I'll show you the rest of your trouble," he invited and started walking the mile and a half to another rise where he repeated his demonstration and, in the same unequivocal tone, stated that another oil pool was located there at a depth of 1,560 ft.

Steve stood silently by with obvious disbelief showing plainly on his heavy features.

"Oh, your outfit is allright, Steve; you just don't eat enough garlic and can't understand what your bug means," was the generous reply of Frank, the single-sticker.

Then he declared again that there were two good pools of oil in that district lying a mile and a half apart and that Steve, with his gyrating doodle-bug, had accidently started doodling on the exact spot centered between them so that the pull from each pool was the same, thus making his bug gyrate in a wide, perfect circle and Steve, not having moved to the right or left, had

A believer in the bottle doodle-bug's oil locating propensities locating a new extension of a field in southwest Texas. The bottle is swinging in a wide circle as the cord by which it is suspended is held in a firm grip by the operator's right hand.

naturally concluded that he was located exactly over oil.

The simplest of all doodle-bugs is of a type that is used less than either of the other two types. It is simply a half-pint size grapejuice bottle, around the neck of which is fastened a small piece of copper wire about 12 or 14 in. long which is suspended across the operator's index finger when he is doodling. In the bottle is the operator's secret mixture.

The operator walks about the area where he is searching for oil and when a pool is to his left, the bottle will swing in a rough curve in that direction; if to the right, the swinging curve is so governed. According to the swing of his bottle, the doodler-bugger walks slowly in that direction until he is directly over the subterranean oil pool. Then, the bottle starts a gyrating movement; if the oil beneath is not in heavy producing quantities, the movement continues at the slow, regular tempo it started with; if there is a large pool below, the gyrations become fast and the bottle swings in a wide circle. The number of gyrations determines the depth to the oil—one complete circle to the foot being the measure. Operators of this type of doodle-bug state that it shows the location of pools beneath pools, also, in precisely the same manner as the single stick doodle-bug does; that is, it will swing to the first pool, hesitate and swing to the next pool, etc.

Questioned about the possibility of pipelines interfering with the correctness of a doodle-bug prophesy, an oldster admitted that such was the case.

"Yes-sir," he affirmed, "Pipelines will throw a doodle-bug off. But I can get around that interference with mine," he added modestly. "All I gotta do is turn my back on the line and go to work; this baby here can't back up: it just swings to the right or left or straight down."

A variation of the bottle doodle-bug is found in one used by a man who, some years ago, borrowed it from the maker and sole user of it. A former West Texas operator of repute states that this original user made and banked in excess of a $1,000,000 with his instrument, then retired. The present user of it was and is an intimate friend of the maker and guards the little device with infinitely more caution and zeal than if it were made of solid gold. And justly so, because he, too, has prospered with it and is still making locations

"You'll get a 1,000 bbl. well here," calmly pronounced the confident operator of the carefully-guarded, mystery-shrouded, cone-shaped doodle-bug. Like most doodlers, he supports one hand with the other when counting the depth of a new discovery.

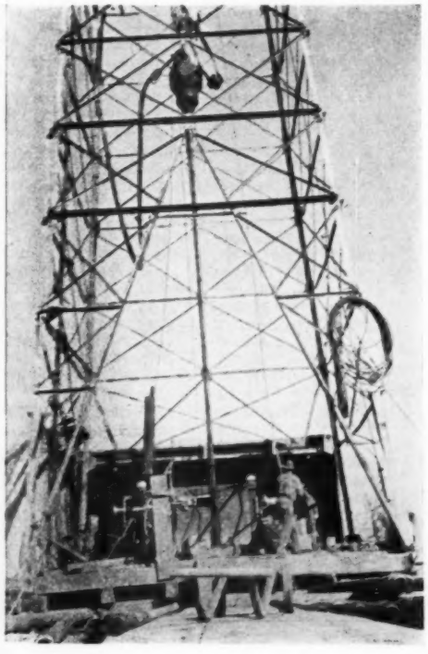
and sharing in the profits if, as and when a proven field results. It is said that he has accumulated over $250,000 through the doodle-bug and is steadily climbing towards his goal—$1,000,000.

This seemingly trustworthy doodle-bug operates exactly like the bottle doodle-bug; its construction and the material differs in the following respects: The mysterious medium is encased in a cone shaped container, covered with a good grade of leather and fastened to a leather thong about 15 in. in length. No one is permitted to try to work this especial doodle-bug; in fact, no one is permitted even to handle it, and as for getting any definite information concerning the contents of that little leather covered cone—one might as well ask either of the two men who have used it and know its secret, to carve their hearts out of their breasts and hand them to you on a silver platter: your chances for the one request are as good as for the other.

MULTIPLES OF EIGHT

A prominent doodler who has followed his willow stick across almost every county in Texas, half of Oklahoma, half of Arkansas and all up and down the western side of Louisiana, has a peculiar theory, supported, in part, by known facts—in part by his doodle-bug testings. He believes that there are oilfields to be found every eight miles on the Balcones Fault coming south from Texarkana, Texas, and crossing the Mexican border at Laredo, Texas. He points to a number of proven fields along that great structural fault line and, true enough, many of them are close to eight miles apart. It is his conviction that future drilling will prove his theory. Following his same multiple, he declares that there is another fault line lying 16 mi. towards the Gulf coast from the Balcones Fault which, when fully proven, will have fields eight miles apart. Then, using the same multiple of eight, he sets forth that 64 mi. farther there is the third major fault line extending across the south and east of Texas.

Drilling commences on a doodle-bug location.



Oil paid for this restful waterfront estate which so charmingly represents the hoped-for ultimate achievement of every doodle-bugger.

A knock against the reliability of the geologists' reports was registered by a doodler in telling a vignette, typical of all oilfields.

"I was over in Arkansas visiting a new field and got acquainted with a man who had been buying oil leases right and left on geologists' reports. One night he come a-running into the hotel lobby yelling at the top of his voice, 'I've lost it; I've lost a fortune!'

" 'How come?' was asked.

" 'How come!' he screamed, 'That's what I'd like to know; how come them damn geologists moved the fault line 50 ft. to the right while I was eating my supper tonight. I lost 10,000 smackers five minutes after the report got out 'cause I didn't hear it first and couldn't turn loose of five leases in time.' "

The great majority of doodlers live from one day to the next; there are exceptions, of course. The two men who have used and zealously protected the conical doodle-bug. One oil man who has a suite of air-conditioned rooms rented by the year at one of Houston's best hotels; makes his own leases and drills his own wells and never makes a lease unless he, personally, has doodle-bugged it, acre by acre: But—after that reassurance, he weakens in his faith in the mystic—he employs a geophysical crew to check his locations. If science concurs with magic, he drills.

One doodle-bugger who has followed his game for 21 years, had the following observation to make, when asked why doodlers don't get rich.

"Some of them have gotten rich but the way it is with me and with most all other doodlers—the men who would help me if they could are as poor as I am and are looking for a break just as hard."

He sighed gently and continued, "You know, there's lots of good fields—as well as bad ones—that are credited to doodle-bugs, and a bug discovered 'em, too, you can bet your bottom dollar on that! But, there are so many quacks in our business who have imposed on people so much that it's almost getting to be a sign that you're teched in the head if you even admit that you ever follered one of the little dancing devils. That's it, son; there's your reason: people don't like to be laughed at."

A battered and oil-soaked felt hat dropped off of the grey head as he leaned wearily back and looked across the fields to where three derricks were racing each other to an early completion. Then his eyes turned to those of his interrogator's but they didn't focus there—as a faint smile flickered across his face for a fleeting instant and he picked up his tale of continuing hopes.

"But all of that is all right. I've got a friend now who's got the cash to drill to China if he wanted to. I'm just a-waitin' for him to drill where I put the peg and then give me a couple hundred acres about four miles south of the test. Yes-sir, I'm a-waitin' and when that comes off, you won't see me sitting in hotel lobbies and drinking my coffee at the five and ten. That'll all be ended then, I'll tell you that for sure!"

WORLD OIL P

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified figures

U. S. BARRELS

	April 1938	May 1938	June 1938	July 1938	August 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Preliminary Figures Mar. 1939
United States	102,702,000	98,674,000	94,277,000	102,898,000	106,165,000	98,661,000	101,830,000	98,567,000	102,287,000	102,490,000	93,475,000	104,500,000
Soviet Union[4]	17,850,000	17,580,000	18,540,000	18,200,000	17,600,000	17,500,000	17,400,000	17,250,000	17,050,000	17,000,000	17,500,000	18,000,000
Venezuela	13,696,219	15,994,400	16,302,150	14,912,555	16,616,673	16,271,096	17,352,171	16,356,204	16,744,163	16,489,347	14,899,459	16,500,000
Iran[5]	7,090,486	6,975,256	5,792,228	5,338,990	5,861,366	5,676,998	7,136,578	7,221,080	6,624,726	7,100,000[1]	6,400,000[1]	7,000,000
Netherland India: Sumatra	2,809,415	2,971,443	2,893,856	2,814,237	2,901,321	2,917,167	3,049,196	3,015,432	3,177,589	3,129,007	2,969,950	3,393,286
Borneo	1,056,224	1,066,281	1,013,163	1,061,980	970,690	1,069,872	1,123,102	1,090,009	1,114,535	1,115,570	1,000,937	1,134,647
Java[9]	639,582	674,927	616,845	585,086	524,384	482,417	523,623	515,160	529,658	535,297	503,441	550,097
Ceram	53,670	51,524	49,870	54,035	54,825	50,355	50,444	45,750	45,773	49,200	55,219	67,442
Roumania	4,090,000	4,169,000	4,015,000	4,115,000	4,075,736	3,915,029	4,028,750	3,847,324	3,969,300	3,934,338	3,638,020	3,940,000
Mexico	2,129,127	2,484,814	2,564,886	2,864,277	3,247,904	3,416,583	3,313,182	3,098,725	3,245,558	2,470,000[1]	1,960,000[1]	2,700,000
Iraq	2,592,996	2,332,746	2,653,579	2,806,903	2,829,528	2,621,547	2,431,949	2,420,143	2,290,777	2,414,878	1,955,122	2,699,272
Colombia	1,642,195	1,819,689	1,826,136	1,826,848	1,870,013	1,797,158	1,891,825	1,863,838	1,908,879	1,710,565	1,633,621	1,791,000
Trinidad	1,418,825	1,481,285	1,431,476	1,500,171	1,505,959	1,514,893	1,594,480	1,503,489	1,664,322	1,652,412	1,499,197	1,630,789
Argentina[1]	1,349,000	1,382,000	1,346,000	1,349,000	1,360,000	1,358,000	1,360,000	1,358,000	2,028,000	2,000,000	1,300,000	1,800,000
Peru[3]	1,296,090	1,343,259	1,303,536	1,335,623	1,328,143	1,280,691	1,331,111	1,303,990	1,321,883	1,251,162	1,103,878	1,300,000
Bahrein[6]	692,403	620,746	661,602	699,176	713,149	714,349	708,962	613,281	623,907	647,988	610,766	658,822
Burma[7]	635,903	667,346	679,368	654,108	637,880	623,630	635,000[1]	650,000[1]	635,000[1]	650,000[1]	500,000[1]	640,000
Canada[2]	464,316	566,086	537,654	693,332	817,706	886,111	685,088	445,514	489,303	531,564	356,218	550,000
Brunei[8]	428,829	445,505	425,184	453,393	448,219	478,080	477,459	484,207	510,500	506,467	453,571	500,000
Great Germany: Old Reich[14]	342,387	329,688	326,842	346,435	342,484	328,098	331,792	307,433	313,206	448,510	330,584	400,000
Ostmark[15]	29,100	32,845	30,000[1]	31,062	29,453	26,772	43,697	29,000[1]	34,259	33,609	46,666	50,000
Slovakia	10,731	10,960	10,159	9,333	11,015	10,933	13,747	10,502	9,879	10,546	9,000[1]	10,000
Poland	315,768	324,803	315,381	314,000[1]	328,115	321,134	330,412	318,000[1]	316,702	326,000[1]	290,000[1]	326,000
Japan[10]	207,522	216,078	216,707	216,707	217,525	170,597	220,451	224,255	173,737	224,885	214,000[1]	220,000
British India[11]	196,543	198,872	192,656	241,191	225,897	217,058	195,000[1]	198,000[1]	195,000[1]	195,000[1]	132,000[1]	230,000
Ecuador	181,331	190,542	188,712	192,360	193,634	189,037	192,702	185,669	192,882	195,556	171,634	181,938
Saudi Arabia	2,382	3,794	3,477	3,550	3,459	40,556	136,947	152,632	139,038	155,605	170,865	215,270
Sarawak[13]	133,248	137,824	132,240	132,007	107,102	123,476	223,165	115,952	118,512	116,030	105,714	120,000
Egypt[12]	88,555	89,935	84,998	83,412	143,978	157,533	208,377	211,841	221,156	308,946	301,102	310,000
Italian Empire: Albania[16]	41,000	42,400	72,300	46,049	4,998	68,655	Nil	Nil	6,220	99,206	67,914	50,000
Italy	9,459	9,563	8,646	9,378	9,057	8,267	8,622	8,533	7,937	7,511	8,090	7,500
France	42,839	48,545	43,189	43,574	43,000[1]	41,104	42,296	40,797	48,000[1]	42,000[1]	40,000[1]	42,000
Hungary	13,775	18,691	26,018	25,888	30,900[1]	38,240	49,800[1]	43,303	47,671	43,000[1]	36,000[1]	48,000
Bolivia[1]	8,800	9,000	8,790	9,500	9,200	8,500	8,800	8,500	9,000	8,800	7,000	8,700
Other Countries[17]	5,800	6,000	5,800	6,000	6,000	50,000	48,000	50,000	48,000	50,000	35,000	50,000
WORLD TOTAL	157,966,520	162,969,847	158,595,448	165,873,160	171,234,333	163,034,936	168,976,728	163,553,563	168,142,012	167,942,999	153,777,968	171,624,763

[1] Estimated.
[2] Includes natural gasoline production
[3] International Petroleum Company and Lobitos Oilfields, Ltd. figures combined.
[4] Russian Sakhalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised—fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	Daily Av. Jan.-Mar. 1939	Daily Av. Jan.-Mar. 1938	Jan.-Mar. 1939	Jan.-Mar. 1938	Daily Av. 1938	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	3,327,389	3,413,589	300,465,000	307,223,000	3,323,984	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	472,222	524,689	42,500,000	47,222,000	564,909	206,192,000	201,856,661‡	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	532,098	490,816	47,888,806	44,173,421	475,360	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	227,777	228,957	20,500,000	20,606,143	214,577	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	105,469	90,837	9,492,243	8,175,324	94,625	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,928
Borneo	36,124	36,072	3,251,154	3,246,521	35,102	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	17,654	20,794	1,588,835	1,871,433	19,056	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	1,909	1,689	171,861	151,980	1,665	607,622	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	127,915	133,697	11,512,358	12,032,692	132,508	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	79,222	134,897	7,130,000	12,140,768	105,495	38,505,824	46,455,687‡	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	78,547	86,374	7,069,272	7,773,686	88,778	32,404,000	30,603,660‡	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	45,946	57,056	4,135,186	5,135,007	59,127	21,581,588	20,297,543‡	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	53,138	45,681	4,782,398	4,111,256	48,592	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	57,778	44,967	5,200,000	4,047,000	46,784	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	40,612	34,044	3,655,040	3,063,953	43,584	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Bahrein	21,306	26,126	1,917,576	2,351,343	22,734	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Burma	19,889	19,405	1,790,000	1,746,472	20,748	7,572,089	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Canada	15,975	15,015	1,437,782	1,351,367	19,004	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,412
Brunei	16,223	13,732	1,460,038	1,235,838	14,759	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Great Germany: Old Reich	13,101	9,796	1,179,094	881,679	10,548	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	1,447	9,327	130,275	83,850	1,014	370,038	221,266	50,092	44,347	27,965	5,765	804
Slovakia	328	374	29,546	33,665	359	130,867	122,790	126,603	136,580	177,797	121,695	126,603
Poland	10,467	10,436	942,000	939,237	10,489	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	7,321	4,973	658,885	447,605	6,880	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	6,189	5,852	557,000	526,653	6,281	2,292,524	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Ecuador	6,101	6,116	549,128	550,409	6,184	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	6,019	103	541,740	9,300	1,356	495,135	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	3,797	4,459	341,744	401,356	4,452	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	10,223	3,016	920,048	271,446	4,277	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
Italian Empire: Albania	2,412	1,378	217,120	124,000	1,199	437,597	380,292	219,693	41,218	17,500	11,437	9,212
Italy	257	296	23,101	26,629	291	106,083	112,700	129,653	128,615	162,449	213,534	242,563
France	1,378	1,400	124,000	125,989	1,414	516,240	507,067	534,063	529,664	700,000	786,366	755,146
Hungary	1,411	446	127,000	40,181	906	330,829	13,910	100	Nil	Nil	Nil	Nil
Bolivia	272	295	24,500	26,530	292	106,620	123,123	104,746	163,295	157,875	111,973	41,907
Other Countries	1,500	193	135,000	17,400	665	243,000	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	5,349,416	5,476,897	482,447,730	492,165,133	5,388,001	1,966,620,613	2,041,168,442	1,797,891,143	1,652,023,331	1,516,760,036	1,438,797,443	1,305,574,242

‡Preliminary

L PRODUCTION

figures in U. S. barrels of 42 gal.—Conversion ratios used are weighed averages for individual countries

METRIC TONS

	April 1938	May 1938	June 1938	July 1938	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Preliminary Figures Mar. 1939
United States	12,916,610	13,357,804	12,762,583	13,939,606	14,507,243	13,189,481	13,785,028	13,343,306	13,846,893	13,874,374	12,653,243	14,140,000
Soviet Union[4]	2,448,000	2,411,000	2,543,000	2,497,000	2,414,000	2,401,000	2,387,000	2,366,000	2,339,000	2,332,000	2,400,000	2,469,000
Venezuela	2,023,972	2,363,588	2,409,066	2,205,195	2,455,545	2,404,477	2,564,234	2,417,054	2,474,385	2,438,207	2,201,782	2,350,000
Iran[5]	937,768	922,528	766,064	706,120	775,208	750,824	943,864	955,040	876,168	940,000[1]	850,000[1]	920,000
Netherland India: Sumatra	378,445	398,988	388,437	377,750	389,439	391,566	409,288	404,756	426,522	420,001	398,651	434,424
Borneo	141,775	143,124	135,995	142,549	130,294	143,607	150,752	146,310	149,602	149,741	134,354	146,543
Java[9]	85,850	90,460	82,798	78,535	70,387	64,754	70,285	515,160	71,095	71,852	67,576	70,426
Ceram	7,204	6,916	6,694	7,253	7,359	6,759	6,771	45,750	6,144	6,604	7,412	8,634
Roumania	558,362	568,874	548,139	561,775	556,415	534,475	550,000	525,232	541,884	537,111	496,658	530,000
Mexico*	316,082	368,886	380,773	425,219	482,171	507,212	491,862	460,025	481,823	367,000[1]	291,000[1]	396,400
Iraq	347,948	312,771	355,803	376,415	379,395	351,508	326,086	324,503	312,734	323,797	262,151	360,817
Colombia	228,878	253,615	254,514	254,669	260,629	250,475	263,669	259,768	266,046	238,406	229,371	250,000
Trinidad	199,666	208,456	201,446	211,113	211,928	213,185	224,385	211,580	234,214	232,537	210,413	229,306
Argentina[1]	192,200	196,900	191,900	192,200	193,800	193,500	194,000	193,500	288,930	285,000	184,000	190,000
Peru[3]	171,759	178,010	172,745	168,725	176,006	167,718	177,893	172,805	175,667	166,281	146,286	170,000
Bahrein[6]	94,457	84,723	90,435	95,428	97,279	97,479	96,660	83,585	85,009	88,264	83,180	89,811
Burma[7]	87,796	92,275	93,797	90,309	88,068	86,101	87,800[1]	89,100[1]	87,800[1]	89,100[1]	70,000[1]	90,000
Canada[2]	58,649	71,511	67,934	87,586	103,298	111,686	86,545	56,280	61,812	67,151	45,000[1]	70,000
Brunei[8]	56,230	58,416	55,552	59,464	58,772	62,688	62,607	63,491	66,939	66,410	59,474	67,000
Great Germany: Old Reich[14]	49,314	47,485	47,075	49,897	45,007	47,256	47,788	45,865	45,111	47,562	47,614	56,000
Ostmark[15]	5,627	4,900	5,800[1]	4,634	4,394	3,994	6,519	5,600[1]	5,111	5,014	6,962	7,000
Slovakia	1,566	1,601	1,484	1,521	1,609	1,597	2,008	1,534	1,443	1,545	1,500[1]	1,500
Poland	41,658	42,850	41,607	41,000[1]	43,287	42,366	43,590	42,000[1]	42,688	43,000[1]	38,000[1]	43,000
Japan[10]	29,518	30,750	30,839	30,839	30,955	24,277	31,376	31,913	24,724	32,003	30,000[1]	32,000
British India[11]	27,136	27,357	26,599	33,300	31,174	29,968	27,000[1]	27,300[1]	27,000[1]	27,000[1]	18,000[1]	33,000
Ecuador	25,175	27,004	26,743	27,262	27,412	26,791	27,310	26,314	27,336	27,715	24,325	23,986
Saudi Arabia	305	492	451	460	453	5,498	18,570	20,697	18,590	21,100	23,169	29,190
Sarawak[12]	17,472	18,072	17,340	17,309	13,913	16,191	16,150	15,204	15,540	15,214	13,862	15,000
Egypt[13]	12,660	12,642	12,151	11,924	20,583	22,521	29,789	30,285	31,617	44,390	43,045	50,000
Italian Empire: Albania[16]	6,060	6,200	10,790	6,873	746	10,247	Nil	Nil	41,674	14,869	10,179	7,000
Italy	1,175	1,188	1,074	1,164	1,125	1,027	1,071	1,060	986	933	1,005	1,000
France	5,999	6,798	6,048	6,102	6,000[1]	5,756	5,923	5,713	6,000[1]	5,900[1]	5,500[1]	6,000
Hungary	1,782	2,418	3,366	3,349	4,000[1]	4,947	6,400[1]	5,602	6,167	6,000[1]	5,000[1]	7,000
Bolivia[1]	1,110	1,130	1,100	1,200	1,160	1,000	1,100	1,000	1,130	1,100	900	1,000
Other Countries[17]	830	850	830	850	850	7,000	6,700	7,000	6,700	7,000	6,000	7,000
WORLD TOTAL	21,479,562	22,320,582	21,770,972	22,714,595	23,589,804	22,178,931	23,356,015	22,900,332	23,094,484	22,994,181	21,265,312	23,302,037

[10] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Nominal figure representing proportion to world total represented by: Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
[18] Official Figures—Petroleos Mexicanos.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

	Daily Av. Jan.-Mar. 1939	Daily Av. Jan.-Mar. 1938	Jan.-Mar. 1939	Jan.-Mar. 1938	Daily Av. 1938	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	451,862	462,002	40,667,617	41,580,161	447,202	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	80,011	78,367	7,201,000	7,053,000	79,066	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	77,667	72,086	6,989,989	6,527,770	76,288	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	30,111	30,281	2,710,000	2,725,311	28,379	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	13,923	12,193	1,253,076	1,097,359	12,775	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	4,763	4,842	428,638	435,776	4,712	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	2,332	2,791	209,854	251,199	2,559	933,595	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	252	227	22,650	20,400	224	81,560	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	17,375	18,247	1,563,769	1,642,387	18,090	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	11,716	20,096	1,054,400	1,802,371	15,662	5,716,423	6,896,657‡	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	10,520	10,791	946,765	971,192	11,904	4,345,000	4,126,185‡	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	7,975	8,742	717,777	786,795	8,241	3,007,935	2,844,251‡	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	7,470	6,444	672,256	579,970	6,748	2,462,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	7,322	6,420	659,000	577,900	6,665	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	5,362	5,984	482,567	538,557	5,753	2,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	2,903	3,394	261,255	305,469	3,098	1,130,734	1,058,557	635,555	173,072	39,008	4,293	123
Burma	2,769	2,735	249,100	246,125	2,875	1,049,493	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	2,024	1,897	182,151	170,715	2,400	876,016	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	2,143	1,811	192,884	162,964	1,937	707,123	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	1,680	1,414	151,176	127,276	1,513	552,074	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	211	187	18,976	16,889	174	63,468	33,010	7,473	6,616	4,172	860	120
Slovakia	51	55	4,545	4,919	52	19,282	17,936	18,665	19,946	25,971	17,776	18,493
Poland	1,377	1,377	124,000	123,910	1,383	504,678	501,301	510,630	614,760	529,200	550,670	556,680
Japan	1,044	1,013	94,003	91,137	976	356,328	341,040	341,976	326,580	266,520	212,667	239,567
British India	700	808	63,000	72,712	868	317,004	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	845	867	76,026	78,006	876	319,877	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	816	13	73,459	1,167	183	66,683	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	490	588	44,076	52,935	548	200,126	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	1,527	432	137,435	38,886	611	223,058	166,298	177,491	176,436	214,671	232,437	265,055
Italian Empire: Albania	356	201	32,048	18,050	179	65,313	56,760	32,760	6,152	2,500	1,707	1,375
Italy	33	37	2,938	3,308	36	13,178	14,000	16,106	15,977	20,180	25,525	27,046
France	193	195	17,400	17,503	198	72,106	71,008	74,788	74,172	98,025	110,120	105,758
Hungary	200	60	18,000	5,406	120	42,798	13,910	13	Nil	Nil	Nil	Nil
Bolivia	33	37	3,000	3,332	36	13,262	15,487	13,197	20,540	19,858	14,085	5,284
Other Countries	222	27	20,000	2,470	93	34,080	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	748,278	756,591	67,344,830	68,133,327	742,424	270,983,994	279,495,814	240,539,340	226,410,486	207,970,753	197,024,849	179,181,741

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Oil Possibilities of Arizona—P. A. Holm in REPORT TO ARIZONA STATE LAND DEPARTMENT, December, 1938.

An opinion has been current that oil possibilities in Arizona do not exist. This opinion is challenged by the evidence presented in this report, although much of the geology of Arizona is still an unknown quantity.

In the plateau province, the areas which are favorable for petroleum exploration include a large part of the Navajo country, various anticlines on the Monument uplift, the Little Colorado River Valley from Cameron to St. Johns, the Rio Puerco Valley between Holbrook and Sanders, the so-called Strip in northwestern Arizona, and Chino Valley.

In southeastern Arizona are included the intermontane valleys of Cochise County such as the San Simon and Sulphur Springs Valley, the Cienega Basin in southeastern Pima County, the Gila Valley near Safford, and some intermontane basins in the vicinity of Tucson.

The Salt River Valley near Phoenix is considered highly favorable for petroleum exploration on the basis of being an intermontane basin containing abundant probable marine sediments, numerous seepages of high gravity oil and probable structural traps underlying the valley fill resulting from folding and faulting.

In southwestern Arizona the Yuma Valley south of Yuma is considered favorable as probably containing sediments of a relic sea (The Gulf of California), and some of the intermontane valleys in southern Yuma County, such as the Mohawk Valley, may contain suitable marine Mesozoic and Tertiary formations.

Subsurface Stratigraphy of Santa Maria (Calif.) Oil Field—Charles Reiter Canfield, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, vol. 23 (1939), No. 1, pp. 45-81.

From stratigraphy, structure, geologic history, and oil production, it is apparent that the Santa Maria Valley oilfield is unique among the oilfields of California. Geologically, there is no other field exactly like it in the state. The disconformities in the Miocene are particularly noteworthy. The fact that wells are able to make more than 5,000 bbl. of oil when the gravity and gas-oil ratio are so low, is indeed surprising.

The principal features of the Santa Maria Valley oilfield may be briefly summarized as follows.

1. Location on north flank of the Santa Maria Valley syncline.

2. Overlap type of trap: Miocene laps northward over the Franciscan, and buttresses against the overlying Sisquoc (late Pliocene).

3. Three thousand feet of closure on top of the Miocene: production coming from wells which top the Miocene with a difference of 3,000 ft. in subsea elevation.

4. Production from the Miocene, both shales and sands.

5. Twenty-five to 10,000 bbl. production of 16.5 deg. gravity crude, with asphalt base, four percent sulphur, 20 percent gasoline and volatile constituents, and averaging two percent water cut. Gas-oil radio only 200:1.

From the standpoint of ultimate production, the Santa Maria Valley oilfield will probably be one of the largest in California. An estimated total production of 500,000,000 bbl. is probably not too large to predict for the field.

South Arkansas Stratigraphy, with Emphasis on the Older Coastal Plain Beds—Warren B. Weeks, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, vol. 22 (1938), No. 8, pp. 953-983.

Recent wildcatting activity in Southern Arkansas has resulted in the finding of four deep pools, and will undoubtedly lead to more widespread deep drilling. The deep drilling already done and better well records in this area since 1934 have added much to the knowledge of subsurface stratigraphy. Wells ranging in depth from 3,000 ft. to 8,327 ft. have disclosed 4,000 ft. or more of sediments below the Travis Peak (Trinity) formation which are generally believed to be Mesozoic in age.

Approximately 1,800 ft. of the Eocene series lies unconformably on the Gulf series. The underlying Comanche series of formations includes Fredericksburg, Paluxy, Glen Rose, and Travis Peak. This series, with an aggregate thickness of 4,600 ft. in the southwest corner of the state, is completely absent within 85 mi. northeast, due to pre-Gulf truncation.

Also truncated at this time, were the underlying 2,250 ft. of Cotton Valley formation variegated shales and sands; the 270 ft. of Buckner red shale and anhydrite; the 870 ft. of Smackover limestone; and the 1,800 ft. of Eagle Mills red shale and salt formation. These lower beds are thought to be Mesozoic in age; however, the Eagle Mills may be older.

The underlying Paleozoic formations are steeply folded and are probably a part of the Ouachita Mountain system.

The formational thinning takes place more in a northerly or northwesterly direction. It is probable that the boundaries of the Comanche seas never extended much farther north than the present Trinity outcrop.

The pre-Comanche beds probably suffered some erosion before the Comanche was laid down. The present boundaries of the Cotton Valley seem entirely due to truncation. It is probable that in its original extent it overlapped both the Smackover limestone and the Eagle Mills formations.

Although the northern limitation of the Smackover limestone is due to truncation rather than formational thinning, it seems probable that it never extended much farther north. In its northernmost occurrence, only the top part of the limestone is present, the basal dense part having been overlapped.

From these observations, it may be inferred that there was continually an overlapping of the younger seas onto the deposits of preceding seas from the Eagle Mills time up through Comanche deposition. During the post-Comanche, pre-Gulf interval, there must have been some rather extensive uplift on the northeast, causing a southwestward tilting of these strata. The following extensive erosion left the present truncated condition of these strata.

GEOPHYSICS

Polar Core Orientation—Dwight C. Roberts and E. Ray Webb, before OIL WORLD CONGRESS, Houston, April 1938. Reprint, SPERRY-SUN WELL SURVEYING CO., Philadelphia.

The idea of determining the dip of a buried sedimentary formation by observing the residual polarity of the heavy minerals in a well core of the formation was originated in 1927, and has at length been developed as a source of valuable geological information.

In practice, a core is taken and marked so as to show which end is the top. It is then sent to a core laboratory where a section is cut and polished and rotated within the field of a magnet to which is attached a small mirror that throws a beam of light on a revolving drum covered by sensitive photographic paper. From the path of the light beam it is possible to compute the dip and strike of the formation. In all cases it is necessary to know the slant of the well (deviation from vertical) at the point where the core was taken.

The value of knowing the true dip of formations or fault planes is invaluable in petroleum and mining work. This method of core orientation lends itself to the solution of such geologic structural problems as those involving unconformities, overturned folds, thrust faults, as well as the determination of normal structures in exploratory work.

Old cores that have been in storage for several years have been tested and have yielded valuable information. Cores have been sent from abroad and successfully tested, indicating that, with proper care in packing, they may be transported great distances without affecting their polar properties.

The following example from practice is given:

An oil company was drilling an exploratory well on the axis of a structure. Upon reaching a depth of approximately 5,000 ft. cores indicated a sudden increase in formation dip. Polar orientation of the cores showed that the high of the lower structure was in an easterly direction from the surface high. The hole was plugged back and directed easterly. Continual coring and polar orientation of cores during this directional drilling operation enabled the company to drill to the high of this structure and then direct the hole vertically downward on the axis until the oil sand was encountered. This well was completed in oil sand at a depth of 5,500 ft., approximately 750 ft. east of the surface location.

Faults in several proven fields have been determined by polar core orientation, thus assisting materially in the development program in these fields.

Many cores from exploratory core holes have been oriented, rendering information which has assisted in proving or disproving geologic structures.

DRILLING

Use of Drill Pipe Protectors in Drilling Open Hole—W. A. Sawdon, in PETROLEUM ENGINEER, vol. 10 (1939), No. 5, pp. 44, 46; 48.

The use of protectors placed on drill pipe for protection of the casing in which the drill pipe rotates, and of the drill pipe itself, has long been standard practice by operators who have consideration for the life of the casing. Lately the idea has arisen of using protectors on the drill pipe in wells that carry as much as 10,000 ft. of open hole, where it may be desirable to protect against both wear of drill pipe and whipping, especially where the formations are hard and abrasive.

To obtain information on the subject an experiment was made on a long string of drill pipe containing a section which was protected with special rubber protectors in the middle of each joint or alternate joints, with long stretches of unprotected drill pipe above and below; records were made of the behaviors of the protected and unprotected sections. The general conclusions are that the whip is reduced; the life of the drill pipe is prolonged; wear on the tool joints is reduced, prolonging their life; reduction of whip decreases metal fatigue; there is decreased torque and increased speed of drilling; all these and other advantages appear to make the use of protectors in open hole a paying proposition, though each well is naturally a separate problem in itself. For best results it appears that there should be one, preferably two protectors per joint.

Casing Used as Drill Pipe to Overcome Heaving Shale—K. C. Slater in PETROLEUM ENGINEER, vol. 10 (1939), No. 5, pp. 25-28.

One of the greatest bugbears of oil well drillers in Gulf Coast oil fields is the presence of heaving shales in many productive districts. These shales are sometimes formidable obstacles which may delay or entirely frustrate completion of the well. Various devices have been invented to overcome the difficulty. The author describes a method which was successfully used in landing and cementing a string of seven-inch casing below a troublesome body of heaving shale in the Valentine field, La Fourche Parish, La. This was done by rotating the casing through it, employing continuous circulation and a cast iron drag-type bit on the casing. The operation was skillfully conducted and quite successful.

Reduction of Drilling-Footage Costs—Claude Johnstone, in OIL WEEKLY, vol. 92 (1939), No. 9, pp. 32; 34.

Under the usual practice of buying a 1,250-ft. drilling line (1⅛ in.) and reversing it once during progress on the well, the average wire line cost is 10.9 cents per foot of hole. This cost is now reduced to 3¾ cents by using a 2,000-ft. instead of a 1,250-ft. line and using only one end when starting a well, the free or unused end being wound on a storage reel. As drilling progresses the worn and unworn ends of the wire exchange places. Eventually both ends become worn, whereupon the centers of two worn lines are spliced to make a line that is practically as good as new. The saving is at least $500 on a 7,700 ft. well in the Shuler field.

Mud Testing Methods Need Expansion—F. K. Daniel, in OIL WEEKLY, vol. 92 (1939), No. 10, pp. 24; 26.

Only a few big companies employ special mud engineers to control the drilling fluid, and these have found that the services of such men are worth paying for. Aside from such cases the testing and control of the mud in many fields leaves much to be desired.

The author contends that even scientific practitioners of mud control overlook some important matters. One of these is the taking of temperatures, which is usually done in the laboratory after the fluid has more or less cooled. The consequence is that the temperature measurements have no relation to the actual state of the fluid at the working temperature, which strongly influences the viscosity of all gels, sometimes in contrary senses. Cases are numerous where a much too viscous mud becomes normal on cooling down, and *vice-versa*. A chemical that is effective in reducing the viscosity of a hot mud has no effect on the cold mud, whereas a thixotropic mud may and sometimes does show an anomalous behavior. The place to measure temperatures and viscosities is right at the mud discharge, using a thermostatically controlled Stormer viscosimeter, otherwise the system of mud control becomes unreliable. The same applies to measurements of the pH, which has a great influence on the properties of the mud, and which may vary greatly with the temperature.

Another factor that appears not to be sufficiently regarded is time. To meet changing conditions in drilling it may be of advantage to alter the properties of the mud by the addition of some chemical. In order to determine the real value of a treating chemical it is not sufficient to test the effect on a low-temperature mud the minute it is added. The test must be made at the actual working temperature and the test kept under observation many hours to note whether the behavior of the chemical is changed by reaction with the mud; the time required for such tests may be reduced by the preparation of charts showing the rate of decomposition of each chemical at different temperatures and each pH.

Existing methods of mud control should be expanded to take account of these factors.

Small Holes Lower Cost of Exploration—Brad Mills, in OIL WEEKLY, vol. 92 (1939), No. 13, pp. 35; 30; 40.

The author summarizes current experience with small holes which are sunk chiefly to obtain geological information and to define producing areas, but might also become producers. The present tendency is to make the diameters somewhat larger than were used when small holes first came into prominence; a difference of one inch may obviate serious difficulties. It is now common to drill holes of about 7¾ inches diameter to 7,000 or 8,000 ft. in search of geological information. The average cost of drilling such holes in the Gulf Coast region is between $1.50 and $3.00 per ft., with at least one contractor offering to drill small exploratory holes 7,000 ft. deep for $2.00 per ft.

The chief advantage of the small hole is the saving of time as well as money. A small-hole outfit working in a local area under favorable conditions can make 10,000 ft. of hole a month. From three to five wells are often required to prove or condemn a salt dome prospect; with heavy drilling equipment these wells might cost $500,000; with a small hole exploratory outfit, four deep holes may be drilled for $100,000 or less.

10,000 Ft. in 29 Days—Glenn G. Merkley, in PETROLEUM WORLD, vol. 36 (1939), No. 3, pp. 28-31; 90.

Present day drilling practice of penetrating the earth beyond a depth of two miles is a tribute to man's ingenuity and skill, but of equal significance is the exceptional progress made in decreasing elapsed drilling time to these depths. Within a year operators have reduced drilling time to 11,500 ft. in the Rio Bravo area more than 50 percent and drilling time in other fields within the last three years has been reduced as much as 75 percent.

The record speed on one of the wells in this field was 29 days to a depth of 10,000 ft., with 52 days required for completion to a total depth of 11,500 ft. Figures are given as follows:

	Days to Drill		
	4000 ft.	8000 ft.	10,000 ft.
One of the initial wells	19	40	70
Average of 18 wells	10	24	45
Best time	6	14	29
Maximum number of bits	10	38	65
Average number of bits	8	25	48
Minimum number of bits	5	16	30

The factors that have contributed to these results are faster rotating speeds and greater weight on the bit, along with bit selection, mud control, size of hole, nature of formation, knowledeg of formation, casing program, and depth of formation. Rotary speeds of 500 r.p.m. have been tried and speeds of 200 to 300 r.p.m. are common. This stepping up of rotary speeds has led to successful changes in design of rotaries and swivels, and an increase of power consumption for driving the rotary; and along with higher rotary speeds there has been a tendency to increased weight on the bit. However, this increase of weight on the bit requires constant and accurate measurement of the weight, and prevention of misalignment. A survey of the drill pipe going in or out of the hole with the alignoscope will disclose bending of pipe or misalignment of drill collars or joints.

PRODUCTION

Effect of Pressure Reduction Upon Core Saturation—H. G. Botset and M. Muskat, in PETROLEUM TECHNOLOGY, vol. 2 (1939), No. 1 T.P. No. 1025; 12 pages.

The amount of reserves in an oil bearing formation and the ultimate recovery of oil therefrom are generally estimated by taking a core of the formation and determining the amounts of oil, gas and water contained in it by a laboratory examination at the surface.

One difficulty of this method is to get the core to the surface in such a manner that its original fluid content is undisturbed, which has so far proved an impossible task. In its natural position the core is under the formation pressure; when this pressure is released some of the contents may exude and be replaced by water from the drilling fluid.

The authors approach the problem from the opposite direction. They take a core sample, extract from it all original oil and other fluids, liquid, or gaseous, and then fill it under pressure with gas and oil, or gas and water, or gas, oil and water, using an apparatus specially constructed for the purpose. Then they release the pressure and determine the final liquid saturation of the core.

The general result is to show that production from such sands as the Berea and the Nichols Buff should be of the order of 25 to 30 percent, with little or no loss of water unless the water content of the sand is abnormally high. Aside from that, the new technique affords a means of determining the probable ultimate recovery to be obtained from oil reservoirs. By releasing the pressure on the filled core gradually over a period of 24 to 48 hours an asymptotic curve is obtained, from which the percent of probable ultimate recovery from the reservoir may be computed.

Gasification of Crude Oil in Reservoir Sands—A. B. Sheinman and others in NEFTYANOE KHOZYAISTVO, vol. 28 (1935), No. 4, (English translation in PETROLEUM ENGINEER, 1939, Nos. 4-5).

From a study of the possibility of setting fire to the residual oil in exhausted oil sands and recovering usable products it is concluded that the problem is solved, in principle. Ignition may be accomplished by means of charcoal or oil placed in the bottom of the hole, or by injection of hot gases. Combustion can be maintained in the sands away from the bore hole.

In an experiment carried out in the Shirvanui field gas produced as a result of the gasification of oil in the sands had an average heating value of 560 B.t.u. per cu. ft. Crude oil is made to flow from the sands to wells from which it can be pumped. Distillates (gasoline and naphtha) were produced, indicating that the process is technologically complex and includes all types of thermal effects such as gasification, pyrolysis, distillation, and condensation. The discharge gases contained as much as 1.7 gal.. of gasoline per 1000 cu. ft. The oil sand acts as an accumulator of heat and all heat supplied to the sands is used in the process.

The influence of the process may spread over a large area. No equipment other than that used in the oil fields is required to carry out the process on a commercial scale.

Pneumatic Pumping Establishes Low Lifting Costs—B. Mills in OIL WEEKLY, vol. 92 (1939), No. 10, pp. 21; 22.

In the Manvel field (Tex.) The Texas Co. uses compressed gas to pump wells ranging in depth from 2,800 to 4,000 ft.; compressed air was originally used but has been discarded. The difficulty with air was that in contact with lubricating oil in the pumphead there is an accumulation of carbon that may result in spontaneous combustion, and there was also an accumulation of water. Both water and carbon troubles have been eliminated by the use of heated natural gas.

One practical result has been elimination of shut downs which were a prime factor in pumping costs. No rod failures have occurred during the past four years in wells equipped with gas-operated pumpheads, a remarkable record in a field offering average pumping difficulties. One pumper handles 28 wells, with nothing much to do but stop and start. The pumping gas is used in a closed cycle under a direct pressure of 220 lb. and a back pressure of 90 lb. The wells produce from 50 to 150 bbl. of fluid a day, with a water cut of nothing up to 40 percent in edge wells. The energy used at each pumphead is about 14 h.p. The cost of operating the compressors and closed gas system has been less than one cent per barrel of fluid lifted (exclusive of labor costs), which is regarded as a record for Gulf Coast fields of similar depths.

NATURAL GAS

Absorptive-Capacity Test for Absorption Oils—D. B. Johns, in OIL AND GAS JOURNAL, vol. 37 (1939), No. 35, pp. 53-56.

The usual method of determining the molecular weight (*M*) of an absorption oil is the benzene freezing-point depression test which is described in the California Natural Gasoline Association Bulletin TS-343, "Tentative Procedure for Testing Lean Absorption Oil." In this procedure small amounts of the absorption oil are dissolved in benzene and the molecular weight is obtained from a measurement of the freezing-point depression. This method is credited with establishing reasonably true average molecular weights and therefore provides a means of determining the actual molal concentration or (D/M) ratio. However, the test requires extremely careful technique to obtain satisfactory results, the time requirement is excessive, and in general the method is unsuitable for determining the actual absorptive capacity of an oil.

This paper presents a quick and simple method of actually determining the relative absorptive capacity of an oil based on its ability to absorb butane gas. Data obtained by this method indicate that the absorptive capacity of an oil is not dependent solely upon the molal concentration factor (D/M), but involves an additional factor which is properly dependent upon the nature of the hydrocarbons of which the oil is composed.

Describing the test briefly, a cross-cut of a liquid isobutane-normal butane stock is vaporized, cooled to 80 deg. F., passed through a small glass flow rate indicator, saturated with water, scrubbed to remove entrained moisture, and finally passed through a measured quantity of absorption oil maintained at 80 deg. F. until equilibrium is attained and the oil will absorb no more butane. The quantity of butane absorbed may be measured either by volume or weight increase.

These weight or volume pick-up values, while indicative of absorptive capacity, cannot be applied directly in computations involving other conditions of absorption. However, by employing equilibrium relations, we may compute *D/Me* values, where *Me* is the apparent molecular weight.

Purification of Absorption Oil in Gasoline Absorption Plants—W. A. Stover, in REFINER, vol. 18 (1939), No. 2, pp. 89-90.

Absorption oil has usually been purified, or reconditioned by distillation in a fire still, with or without fractionation; in some cases use is made of a vacuum still.

In a more recent type of still for this purpose the unit consists of a still, or tank with sprays and baffles and a heater; it works in conjunction with the main absorption plant still, requiring no condenser, condensate receiver, or pump; the pressure is a few ounces above that of the main still to which it is connected. Steam is admitted into the purifying unit and evaporates the lighter fractions from the absorption oil; this steam, saturated with oil vapors, flows into the absorption plant still, performing there its stripping function in the usual way. The heat required is supplied by preheating the steam in the heater. No extra steam is required, as the heat required for the heater practically is balanced by its more efficient action.

Only about one percent of the total oil circulation passes through the oil purifying equipment. This is sufficient to prevent accumulation of sediment and gum in the circulating oil.

In existing plants where units of this type have been installed a deciced improvement in plant operating efficiency has been experienced. It has been found that after four to six weeks of operation of this unit the absorption oil has been completely reconditioned and that its quality is equal to that of new oil. It also has been found that no dumping of absorption oil is required, thus eliminating quite a sizeable yearly expenditure in some plants.

Gas Distillate Production in South Texas—Earl S. Post in REFINER, vol. 18 (1939), No. 2, pp. 80-82.

Development of condensate production along the South Texas Gulf Coast is taking form in a vigorous natural gasoline plant and recycling unit construction program. This has followed as a result of a fuller comprehension of the nature of certain hydrocarbon deposits which exist under high gas pressure; when these deposits are tapped a considerable amount of natural gasoline is recovered from the escaping gas. It has been found, however, that as the formation pressure is lowered the amount of condensate becomes smaller. To account for this it has been suggested that relief of the pressure causes the liquefiable constituents of the gas to condense in the sands, where they are not recoverable by any known means; hence it is necessary to keep up the pressure by recycling the stripped gas back to the formation.

The theory that it is the pressure that keeps the condensible hydrocarbons in the vapor form and thus enables them to be brought to the surface has been proved in tests conducted in connection with certain recent litigation. Fluid produced from the 5,700 ft. sand in the Saxet field, together with water and gas, were experimented with by Dr. George G. Brown, professor of chemical engineering at the University of Michigan, in his laboratory at Ann Arbor. These samples were mixed in their exact ratios as found at the separator at the well site. When subjected to a pressure of 2,850 lb. and 168 deg. F., considered the same conditions as in the well, the liquids were transformed into gas. As the pressures were lowered, the gas commenced to condense, turning into fluid when the pressure reached 610 lb. and temperature 70 deg. F.

TRANSPORTATION

Naval Tankers of the World—B. Orchard Lisle, in OUR NAVY, vol. 33 (1939), No. 22, pp. 4-7; 16.

A necessary corollary of the present great expansion of oil-powered warships is the construction of naval oil tankers, which are increasingly necessary on account of the wide cruising range of modern war craft. There are now some 44 naval and quasi-naval tankers aggregating more than 389,290 tons deadweight built, building or projected by the governments of 11 nations, with speeds ranging from 10.5 to 20 knots loaded. When these are completed the total number of oilers in direct or indirect military service will be at least 316 vessels, of more than 2,138,319 tons deadweight, with perhaps further building in the next few years. In time of war all governments would naturally have the use of privately owned tankships.

As regards distribution, Great Britain has the largest number of naval tankers (67) as against 34 for Japan, but the Japanese vessels have a considerably greater total deadweight than the British and besides being larger the Japanese vessels are mostly faster. Italy has 39 tankers, but these are mostly small. At the end of the present construction program the United States will have 33 naval tankers, with about the same aggregate tonnage as Japan.

Moving Oil Through Pipes in Freezing Weather—John Albright, in OIL WEEKLY, vol. 92 (1939), No. 9, p. 48.

On a pipeline in Michigan where temperatures remain low for months at a time during winter a part of the oil stream was by-passed through a gas-fired heater, thus raising the temperature of the whole stream and greatly increasing the carrying capacity of the line. The gas feeding the heater is obtained from a gas line that parallels the oil pipeline.

Note: This suggests that oil pipelines remote from gas lines might be heated by installing an oil burner that would take its fuel from the pipeline itself; no doubt some inventor could solve the problem. The same idea is of course applicable to gas lines to prevent clogging by the separation of gas-hydrates in cold weather.—ED.

REFINING

Glacial Acetic Acid in Petroleum Refining—S.S. Bhatnagar and P. J. Ward in INDUSTRIAL ENGINEERING CHEMISTRY, vol. 31 (1939), No. 2, pp. 195-199.

Acetic acid is found to be an excellent agent for improving the smoke point of kerosenes. Experiments on the matter have progressed to the pilot plant stage on a scale of 300 bbl. of heavy kerosene a day; treatment with 125 percent by volume of

glacial acetic acid effects an increase of smoke point from 14.5 to 24.5 mm. The total yield of salable kerosene is around 90 percent, the rest being separated as fuel oil.

The pilot plant operations are divided into the following six operations:

1. Continuous countercurrent extraction of the kerosene fraction with glacial acetic acid.
2. Continuous countercurrent washing of the raffinate from operation 1 with recovered wash water from an azeotropic distilling system.
3. Continuous countercurrent precipitation of oil from the extract of operation 1, using the combined aqueous acid solutions from the raffinate, precipitated oil, and fuel oil washings.
4. Continuous countercurrent washing of precipitated oil with recovered wash water from the azeotropic distilling system.
5. Continuous azeotropic distillation of the aqueous acid-fuel oil solution obtained from the precipitation stage, to recover glacial acetic acid and substantially acid-free wash water and to obtain a residue containing some acedic acid.
6. Continuous countercurrent washing of the residual fuel oil-acid solution from the azeotropic distillation with recovered wash water.

A final slight alkali wash is given to prevent corrosion of storage tanks.

A study was made of the relative value of glacial acetic acid as a selective solvent in the refining of lubricants. It is found that raffinate from nitrobenzene was superior to that from acetic acid in respect of resistance to oxidation where similar viscosities were obtained, although the yield with acetic acid is considerably higher for a given degree of improvement in viscosity index. The same holds true in comparison with furfural and perhaps other solvents.

Survey of Fuel Consumption at Refineries, 1937—G. R. Hopkins, in BUREAU OF MINES REPORT OF INVESTIGATIONS 3430, December, 1938.

A fifth successive record in fuel efficiency was established by the petroleum-refining industry in 1937, when the average heat requirement per barrel of crude oil run to stills was 554,000 B. t. u. compared with 597,000 B. t. u. in 1936. These amounts represent roughly the heat obtainable from a tenth of a barrel of fuel oil.

Innumerable factors can influence heat consumption at refineries, but only a few are important enough to be subject to statistical measurement. Foremost of these is the ratio of runs to capacity, it being generally recognized that because the fuel demands for other than stills are comparatively inelastic, total heat requirements do not increase in direct proportion to crude runs. Thus, in 1937, crude runs of 1,183,440,000 bbl. were 11 percent higher than in 1936; the average operating ratio was 83 percent compared with 78 percent in 1936; but the total heat requirement increased only four percent, or from 638,149,000,000,000 B. t. u. in 1936 to 663,866,000,000,000 B. t. u. in 1937.

Another factor of primary importance in reducing fuel requirements has been the continued expansion of the practice of heat exchange. Heat exchangers may now be found at an amazing number of points in the refinery stream, so many, in fact, at some plants as to suggest that construction has been overdone. However, a few scattered mistakes cannot obscure the excellent fuel-economy record of heat exchangers, a record that became even more outstanding in 1937, particularly by construction at combination plants.

Italian Plants for Hydrogenation of Fuels—Giovanni Coppa, in PETROLEUM ZEITSCHRIFT, vol. 35 (1939), No. 11, pp. 190-194.

The two refineries at Bari and Livorno are equipped to treat Albanian crude oil production which has now been stepped up to about 300,000 tons a year. Gasoline is being produced at the rate of 240,000 tons a year, of which about 100,000 tons is aviation gasoline, and about 60,000 tons of lubricating oil.

After a topping distillation the crude oil is fractionated to produce gasoline, middle oil and residue. The middle oil is cracked to produce more gasoline, gas for making hydrogen, and pitch that is either burned or made into asphalt. The residues are hydrogenated in two phases. In the liquid phase use is made of a finely divided catalyst, a temperature of 500 deg. C. and a pressure of 300 atm. A solid catalyst is used for hydrogenation in the gas phase. These refineries have been designed with a view to future hydrogenation operations on domestic shale oils and lignites.

Hydrogenation Plans in France—Editorial, REVUE PETROLIFERE, No. 825, Feb. 17 (1939), p. 197.

Existing and proposed plants for the production of aviation gasoline of high octane number by hydrogenation include the following:

A plant at Donges where the charging material will be oil; this plant will turn out 70,000 tons of gasoline by the S.N.R. process.

At Pauillac, where the Societe Jupiter's refinery will produce 100,000 tons of gasoline a year without any governmental assistance by ordinary hydrogenation processes; the raw material will be petroleum residues.

At Martigues the C.F.R. will make 30,000 tons of gasoline a year, using either petroleum residues or the lignites of Gardanne according to the process employed in the existing coal-hydrogenating plant at Bethune.

At Decazeville will be established a plant to turn out 30,000 tons a year by hydrogenating coal.

In sum this program contemplates the production of 230,000 tons of gasoline a year. The projects will be financed by government loans and in some cases the state will be a stockholder.

Tetraethyl Lead Susceptibilities of Gasoline: Doctor Treatment vs. Caustic Washing—L. M. Henderson, W. B. Ross and C. M. Ridgway, in INDUSTRIAL ENGINEERING CHEMISTRY, vol. 31 (1939), No. 1, pp. 27-30.

Large quantities of tetraethyl lead are being used daily by the petroleum industry for the purpose of increasing the antiknock value of gasoline. Inasmuch as different gasoline stocks require different amounts of tetraethyl lead to produce specific antiknock ratings, an investigation of the factors which affect the tetraethyl lead susceptibility of gasolines is of economic importance. One of the factors requiring serious consideration is the influence of refining processes. Many observers have noted that the tetraethyl lead susceptibility of gasoline stocks decreases to a greater or less extent on treatment with the conventional doctor solution (sodium plumbite) and sulphur. This treatment is applied quite generally at present for the purpose of eliminating the odor due to certain mercaptans normally found in gasolines in relatively small amounts. This treatment converts substantially all mercaptans in the gasoline, malodorous as well as those without objectionable odor, into disulphides which remain in solution in the gasoline. A gasoline thus treated will pass the so-called doctor test. There is however, a possibility that the doctor test is much more severe than is justified on a basis of intrinsic qualities of a gasoline.

A gasoline containing, for example, 0.0007 per cent mercaptan sulphur will normally pass the doctor test, while another containing but slightly more mercaptan sulphur—namely, 0.0012 percent—will generally not pass the test even though the former sample may contain much more total sulphur than the latter.

The unfortunate feature of the so-called doctor test when written into gasoline specifications lies in the fact that it necessitates processing a product to meet an arbitrary test that apparently is not adequately related to the merits or intrinsic qualities of the product.

The experimental evidence presented shows that, when gasolines are treated with sodium plumbite and sulphur, they require more tetraethyl lead to produce a given octane value than do those treated with sodium hydroxide alone and, similarly, more than do those which are thoroughly scrubbed with caustic and subsequently treated with sodium plumbite and sulphur. The differences in quantity of tetraethyl lead required are related qualitatively to the amount of mercaptan sulphur removed by the caustic washing.

The decreased requirements of tetraethyl lead accomplished by efficient scrubbing of gasoline with sodium hydroxide solutions would result in large economic savings to the petroleum industry.

Filtrol Fractionating Plant—M. M. Moore and H. M. Gwyn, in REFINER, vol. 18 (1939), No. 2, pp. 45-48.

Filtrol fractionation is a term applied to a process in which a finely divided activated bleaching clay is injected into a hydrocarbon oil stream as it flows to some form of fractional-distillation equipment. The purpose is to accomplish fractional-distillation and contact-clay decolorization in a single and more economical operation. This problem has been attracting attention for some years but first reached its most successful stage of development in the treatment of long residuums; lately it has been used for this purpose at the Richmond refinery (Standard Oil Co. of Calif.) for finishing lubricating oils. The process as applied in this refinery is described by the authors with particular attention to the chief factors: careful control of contact time and temperature, steam stripping and continuous filtering of the products, and completely automatic clay handling.

Besides application to solvent-treated long residuum, filtrol fractionation can be used with advanage in other stages of lubricating oil refining.

For example, it can be employed on solvent mixtures of lubricating oils which have been made up to facilitate other refining steps, as in the case of naphtha solutions prepared in connection with centrifuge de-waxing. In this instance, after centrifuging, conventional practice calls for a naphtha stripping operation followed by decolorization with bleaching earth. By employing the Filtrol fractionation principle, both of these latter operations can be accomplished simultaneously. Again, crude oils containing but small amounts of asphaltic material, and those in which the asphaltic content has been materially reduced, can be refined by this process. Such units produce better quality naphthas, kerosenes and intermediate fractions, in addition to finished lubricating cuts of the desired color. Sour or neutralized long residuums which are being subjected to vacuum distillation and clay finishing appear to be another phase where this process can be profitably employed.

New Developments in Steels for Oil Refinery Service—Martin Fleischmann, before WESTERN PETROLEUM REFINERS' ASSOC., San Antonio Meeting, March, 1939.

There are certain definite characteristics steels must possess in order to render satisfactory oil refinery service. In the development of new steels special consideration has to be given to each of these factors for a steel may be outstanding in certain

respects and still be incapable of good performance if certain of its other characteristics are undesirable. For example, some analyses may possess high strength combined with good oxidation and corrosion resistance and yet be unsatisfactory because they become brittle during service.

The standard 5 Cr-Mo steel now has a service record of many years. It has been found, however, that the characteristics of this steel can be further improved by the addition of other elements. As an example, the oxidation and corrosion resistance is increased by the addition of silicon, as in Sicromo 5, or by the simultaneous addition of silicon and aluminum, as in Alcrosil 5 steel. The influence of aluminum in decreasing the air hardening characterictics adds additional value to this latter composition.

Type	C	Mn	Si	Cr	Mo	Cost 4-6% Cr-Mo=1.0
Sicromo 5	.15 Max.	.50 Max.	.50/1.00	4.00/ 6.00	.45/ .65	1.00
Sicromo 5M	.15 Max.	.50 Max.	.50/1.00	4.00/ 6.00	.90/1.10	1.07
Sicromo 5S (Formerly Sicromo 5)	.15 Max.	.50 Max.	1.00/2.00	4.00/ 6.00	.45/ .65	1.06
Sicromo 5MS	.15 Max.	.50 Max.	1.00/1.50	4.00/ 6.00	.90/1.10	1.12
Sicromo 7	.15 Max.	.50 Max.	.50/1.00	6.00/ 8.00	.45/ .65	1.11
Sicromo 7M	.15 Max.	.50 Max.	.50/1.00	6.00/ 8.00	.90/1.10	1.16
Sicromo 7S	.15 Max.	.50 Max.	1.00/1.50	6.00/ 8.00	.45/ .65	1.14
Sicromo 7MS	.15 Max.	.50 Max.	1.00/1.50	6.00/ 8.00	90./1.10	1.18
Sicromo 9	.15 Max.	.50 Max.	.50/1.00	8.00/10.00	.45/ .65	1.50
Sicromo 9M	.15 Max.	.50 Max.	.50/1.00	8.00/10.00	90/1.10	1.62

Recent work has been concentrated on steels to fill the gap between the 5 Cr-Mo and the stainless types. As a result of this commercial steels are available to the refinery engineer.

These steels are of the chromium-molybdenum-silicon type with chromium contents of five, seven, and nine percent, respectively. These steels are available with both 0.50 and 1.0 percent molybdenum, depending upon the strength requirements, and with varying silicon content to assure satisfactory surface stability. The comparative price ratio is likewise included in this table in order to assist in the selection of the most economical composition for a given application. The stress-rupture characteristics of certain of these Sicromo steels at 1,200 and 1,300 deg. F. are given.

Catalytic Cracking of Aliphatic Hydrocarbons—G. Egloff, J. C. Morell, C. L. Thomas and H. S. Bloch, before AMERICAN CHEMICAL SOCIETY Baltimore Meeting, April, 1939.

The thermal decomposition of long-chain aliphatic hydrocarbons is characterized by non- selective chain scission which is undesirable from a utilitarian viewpoint. A review of the field led to the conclusion that difficultly reducible refractory oxides were the best potential catalysts for carbon-carbon bond scission. In the present work the effect of an activated silica-alumina mass on the decomposition of n-octane, octene-1 and -2, cetane, and cetene was studied under conditions which allowed comparisons between the catalyzed and the uncatalyzed reactions, the cracking of paraffins and olefins of the same chain length, and of homologues in both the paraffin and the olefin series.

The results are given as follows:

A mixture of octenes-1 and -2 underwent both catalytic isomerization to iso-octenes and catalytic cracking to gaseous products consisting principally of equal amounts of normal and iso-butene. The results are consistent with the theory that isomerization preceded cracking. In the temperature range 375 to 400 deg. C. the conversion was over 80 percent.

The primary catalytic reaction of cetene in the range 300 to 450 deg. C. was isomerization to iso-hexadecenes; the secondary reaction is cracking to lower-boiling olefins, accompanied by isomerization of normal olefinic products to iso-olefins. The iso-hexadecenes catalytically cracked approximately three times as rapidly as cetene itself.

n-Octane catalytically cracked 7 to 8 times as rapidly as in thermal decomposition, and the catalytic products contained more C_5-C_7 hydrocarbons and less methane, ethane, and ethylene than the pyrolytic products. The temperature required for the catalytic cracking of octane was 200 deg. C. higher than that required for n-octenes.

Cetane was catalytically cracked largely to C_3, C_4, and C_5 hydrocarbons. The gasoline boiling-range products contained both branched-chain and straight-chain hydrocarbons, in contrast to the products of cetene cracking, which were essentially all branched-chain.

Although the behavior in thermal cracking of cetane and cetene is quite similar, cetane is far more stable toward catalytic cracking than cetene. In both cases, the products of catalytic cracking are quite different from those of pyrolytic cracking.

CHEMISTRY

Accelerated Oxidation as a Control Test in the Acid Treatment of Cracked Gasoline—A. Newton in JOURNAL INSTITUTE OF PETROLEUM, vol. 25 (1939), No. 183, pp. 24-31.

The accelerated oxidation test supplies a convenient method of estimating how long a cracked gasoline is likely to remain free from excessive amounts of gum kept in storage. This well-known method consists in placing a sample of the caustic-washed and doctor-treated cracked gasoline in a bomb with oxygen at 100 atm. pressure and 100 deg. C., and determining the amount of oxidation that results.

However, it has been observed that this test, while showing the oxidizability of the gasoline, cannot be correlated satisfactorily with the method of treatment to which the cracked gasoline has been subjected. A gasoline that has been treated by a certain refinery process will be found to have a certain induction period, while another gasoline treated by exactly the same process will have a different induction period. The oxidation test therefore is not a means of comparing the efficiency of refining processes.

The explanation is that different gasolines contain different kinds and amounts of natural inhibitors, which pass through the refining process unchanged and give the corresponding gasolines different induction periods.

The object of the present research was to find a method of removing these natural inhibitors so that the efficiencies of refining processes could be more clearly judged. The method as finally worked out depends on converting the natural inhibitors, which are mostly of a phenolic nature, into a form such that they may be washed out with water.

The sample is washed with caustic, sweetened with plumbite and sulphur and treated with a solution of diazotized sulphanilic acid. This brings the phenols into solution in the form of a water-soluble azo dye so that they may be removed. Other important characteristics of the cracked gasoline are not affected.

The routine use of this method of preparing samples has shown that induction periods can consistently be duplicated within the limits of experimental error. It has also shown that the true induction period (inhibitor-free) of cracked gasoline rarely exceeds 250 min. and is usually somewhat lower, and that the course of induction period improvement by acid treating is rather different from that previously found. An initial, relatively small treat appears to remove the whole of the highly unstable di-olefins which are present to the extent of about one percent. in liquid-vapor phase-cracked distillate. Increase in the amount of the treatment thereafter produces a comparatively small improvement in induction period corresponding to a slight decrease in the ratio of mono-olefins to saturated hydrocarbons in the residual spirit.

Comparison of Methods of Determining the Iodine Number of Motor Fuels—M. Richter, in OEL UND KOHLE, vol. 15 (1939), No. 4, pp. 69-75.

An important feature of petroleum products is their condition of saturation or unsaturation, or the presence or absence of double bonds, which are capable of absorbing various chemicals. The extent of this unsaturation is measured by ascertaining how much iodine or bromine will be absorbed by the petroleum product.

There are five common methods for this determination, which the author has subjected to a critical comparison. The results indicate that preference should be given to the Hanus method, in which the reagent used is 10 grams of iodine-monobromide in 500 cc. of glacial acetic acid; carbon tetrachloride is used for dissolving the oil sample.

The Hanus method is preferred because it gives a distinct end-point after a short reaction time (60 min.) and because the iodine-bromide reagent is stable.

The McIlhinny method is unusable for rapid work, but when addition and substitution of halogens are simultaneously noted it can be used successfully for studying problems of constitution. The Wijs method stands next to the Hanus method, but does not give a clear end-point with all oil products within a reasonable time of reaction, and besides, the operating procedure is inconvenient. The end-point of the Hubl method is too indistinct and the results generally too low, and the same is true of the Kaufmann method.

Hydrogenation of Roumanian Crude Oil—C. Candea and J. Kuhn, in MONITEUR PETROLE ROUMAIN, vol. 40 (1939), No. 2, pp. 81-83.

This research was carried out with the special object of comparing hydrogenation operations in rotating and fixed autoclaves. The oil used was a Buscani crude, the catalyst a mixture of MoS_2, MgO, and Al_2O_3 in the proportions 10:3:2; the temperature was up to 450 deg. C., hydrogen pressure up to 279 atm.

The results showed a much higher yield (up to 62 percent) of gasoline (boiling up to 150 deg. C.) from the rotating autoclave, evidently due to the more intimate mixing of the catalysts with the charge. The amount of catalyst was 10 percent of the weight of the charge. There was no action at a temperature below 300 deg. C.

Catalytic Aromatization of Aliphatic Hydrocarbons—H. Koch, in BRENNSTOFF-CHEMIE, 1939, pp. 1-9 (REV. PETROL. 1939, p. 54).

The author undertook an experimental investigation to verify statements made in the literature particularly as regards patents which claim yields of 75 percent in a single pass in the catalytic aromatization of aliphatic hydrocarbons. The catalysts employed were vanadium oxide and chromium oxide, the two being supported on aluminum oxide.

The experiments with n-hexene and n-heptene failed to give the indicated 75 percent yields of benzol and toluol per pass. A fraction of kogasin (a Fischer-Tropsch synthetic petroleum product) boiling between 92 deg. and 95 deg. C. and containing 68 percent of heptenes gave, at temperatures between 400 and 530 deg. C. principally toluene, the maximum yields of aromatics per pass being 55 percent. At the same time, secondary molecular splittings and polymerization to higher molecular weights decreased the activity of the catalyst, which could be

restored by re-oxidation. The experiments were varied by passing heptene, heptane and octane over platinized carbon at 310 deg. to 350 deg. C., but the aromatization is less intense than with the oxides of vanadium and chromium.

The general result is to confirm statements in the literature that it is possible to aromatize aliphatic hydrocarbons by catalytic means to an important extent. The best results are obtained when operating on individual chemical compounds, or on narrow fractions, because the optimum conditions of temperature and time of contact depend on the molecular size and structure of the hydrocarbons. This is of course what is usually done in non-catalytic cracking, where the raw material is separated into close fractions which are then separately submitted to the cracking operation.

Isomerization of Heptane, Octane, and Alpha-Hexene—A. D. Petrov, A. P. Meschcheryakov and D. N. Andreev. Translation issued by Petroleum Division of AMERICAN CHEMICAL SOCIETY.

The object of this work was to study the isomerization of low molecular weight hydrocarbons without cracking or polymerization in the presence of catalysts. The experiments showed:

(1) That the temperature limit of isomerization is near to that of cracking and especially of polymerization (for olefin hydrocarbons); (2) that it is possible to bring about isomerization of normal heptane to the extent of 20-25 percent by heating with zinc chloride at 300 deg.-400 deg. for six hours; (3) that normal heptane undergoes isomerization to a marked extent at 420 deg. in the presence of molybdenum trisulphide, the extent of isomerization evidently increasing with the increase in the heating period from three to 14 hours; (4) that in the presence of molybdenum trisulfide normal octane is isomerized at 410 deg. and undergoes a very extensive isomerization accompanied, however, by considerable cracking at 440 deg.; (5) that finally, molybdenum trisulfide is even a stronger isomerizing agent than zinc chloride but weaker than aluminum chloride.

With regard to alpha-hexene, it was found that this hydrocarbon, while remaining unchanged on heating up to 300 deg. in the presence of molybdenum trisulfide, begins to polymerize at 350 deg., the polymerization being quite substantial at 400 deg. Unlike paraffin hydrocarbons no fractions are formed that boil below the initial hydrocarbon. Oxidation after isomerization (heating for one hour at 400 deg. under a pressure of 140 atm.) of the fraction boiling approximately within the limits (somewhat higher, to be exact) of the boiling range of alpha-hexene showed that alpha-hexene became isomerized to a condiderable extent into beta-hexene and to an insignificant degree into gamma-hexene. No isohexenes were found.

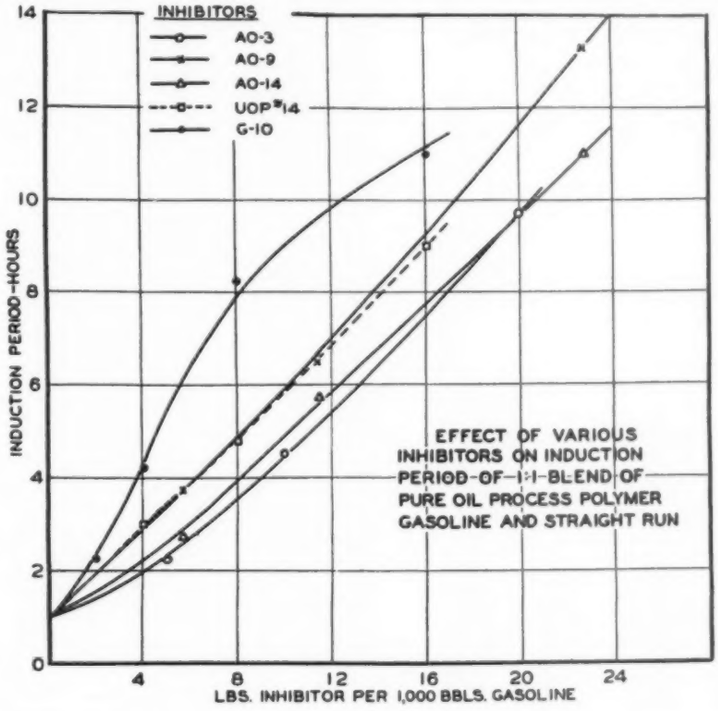
These data evidently show that destructive hydrogenation (catalytic hydrogenation under hydrogen pressure) has considerable advantages over reforming cracking with regard to the extent of isomerization, and also that reforming cracking of straight run gasoline (accompanied, of course, by formation of olefinic hydrocarbons to some extent) is advantageously carried out in the presence of active catalysts as an isomerization reaction, also at lower temperatures for the purpose of reducing the loss of low boiling fractions through side reactions of polymerization of olefinic hydrocarbons.

Determination of Gum in Heavy Oils—F. L. Smith and E. B. Shannon, in REFINER, vol. 18 (1939) No. 2, p. 53.

The air-jet method of determining gum content (A.S.T.M. D381-34T) is inapplicable to oils heavier than kerosene. To obtain comparative gum figures on heavy oils the authors dilute with light petroleum naphtha, shake several times with absolute alcohol (95 percent denatured alcohol will not do), and evaporate the oil-free extract to dryness. With ordinary precautions results are obtained that check within less than a milligram. While this method does not give the same results as in other currently used methods it does give excellent information for comparing the gum contents of heavy oils.

Action of Inhibitors on Polymer Gasoline—W. B. Ross and L. M. Henderson, before WESTERN PETROLEUM REFINERS' ASSOC., San Antonio Meeting, March, 1939.

As a consequence of the method of manufacture, polymer gasoline is more or less susceptible to atmospheric oxidation even as is ordinary gasoline. Data are presented which show that the addition of small amounts of commercially available anti-oxidants to Gray treated poly distillates inhibits gum formation even as they do in conventionally cracked gasolines. The experimental results reported in this paper represent data furnished privately by Dr. Gustav Egloff relative to the use of inhibitors in gasoline produced by catalytic polymerization process, or from the work of The Pure Oil Company on their polymerized gasoline. These data show that the stabilization of gasoline toward gum formation is easily and satisfactorily accomplished by the addition of inhibitors.



Data are exhibited on the effect of tetraethyl lead on the susceptibility of gasoline to inhibitors. The figures show that the tetraethyl lead has little or no effect on the inhibiting action.

Catalytic Alkylation of Isobutane with Gaseous Olefins—F. H. Blunck and D. R. Carmody, before AMERICAN CHEMICAL SOCIETY, Baltimore Meeting, April, 1939.

In this work the paraffin in all cases was iso-butane and the olefins employed were ethylene, propylene, and iso-butylene.

The catalysts used were double compounds of alkali halides and aluminum halides which are prepared by heating equal molecular quantities of the anhydrous chloride and the halide, previously mixed, to 500 deg. F. The pure melt is poured over 8-mesh pumice and well mixed. The olefin-paraffin mixture was flowed over the catalyst under varied conditions of temperature and pressure.

There is evidence to show that alkylation is quite considerable at the beginning, but the reaction soon becomes complicated as the catalyst declines in activity.

USE

Spark Plugs and Knock Resistance—F. Fischer and H. Pohl, in BRENNSTOFFCHEMIE, 1938, pp. 458-460 (Rev. Petrol. 1939, p. 54).

It is known that engine knock can be diminished not only by using fuels of high anti-knock rating, but also by hot spots on the walls of the cylinder. The hottest points within the cylinder are undoubtedly the electrodes of the spark plugs, which are generally made of special alloys of high melting points. However these alloys are not as good conductors of heat as pure metals. On this account, when pure metals are used for the electrode the sparking is less intense and the knock is diminished.

Experiments along this line were made with an I.G. motor taking as a measure the quantity of residual unexploded gas in one minute. The corresponding octane numbers were then ascertained by comparison of a mixture of two secondary reference fuels (benzol and normal I. G. gasoline), the composition of the mixtures being adjusted so that the two spark plugs under examination would explode the same quantity of gas per minute.

The metallic electrodes used in the investigation were aluminum, copper and brass. When used in two different types of spark plugs (Bosch DM 175 A3 and Siemens AG 30/5) no difference was observed with aluminum electrodes. On the other hand the quantity of unexploded gas passed in one minute by copper electrodes was 20 cc. against 33 cc. by a Siemens plug under the same conditions. For giving the same quantity of unexploded gas—37 cc.—the copper plug needed 54.7 octane, the Seimens plug

58.3 octane. This means that by using a copper plug, a gasoline 3.6 octanes lower can be employed for the same degree of knocking of the motor. For brass the difference is only 2.2 octanes.

Cooperative Fuel Research Motor-Gasoline Survey, Summer, 1938—E. C. Lane, in BUREAU OF MINES REPORT OF INVESTIGATIONS NO. 3429, December, 1938.

This is the sixth in a series of reports on the properties of commercial motor fuels, made in accordance with a cooperative agreement between the Cooperative Fuel Research Committee (C.F.R.) and the Bureau of Mines.

Comparison of the data shows an increase over the previous summer survey in the octane-number ratings of regular-priced gasolines of one number in the lower end and ½ number in the upper end of the range of 90 percent of the samples. Thus, the range of octane ratings of regular-priced gasolines is both narrower and higher than the corresponding ranges for the survey of the summer of 1937. The octane ratings of premium-priced gasolines in this survey also cover a narrower and higher range than for the previous summer survey, and the octane ratings of 90 percent of third-grade gasolines show a slightly narrower range, and the interval between minimum and maximum octane ratings in this grade is approximately eight octane numbers wider than the corresponding range in the previous summer survey.

The range in the vapor pressures of 90 percent of the regular-price gasolines is nearly identical with that of the previous summer survey, although the minimum and maximum points are somewhat higher in the present survey. In general, the same is true for both premium-price and third-grade gasolines. There are no significant changes in distillation temperature from the previous summer survey.

Paper Bottles for Oil—K. O. Muller in OEL UND KOHLE, vol. 15 (1939), No. 8, pp. 151-153.

Pursuing their program of national self-sufficiency, the Germans have turned their attention to paper bottles for oil, with an eye especially to military requirements. Owing to the extensive mechanization of a great modern army, the consumption of lubricating oil is very large, especially when the army is in motion, as during a general war. A military tank, for instance, needing oil cannot always drive up to a filling station, but must carry its supply with it. Glass bottles are out of the question on account of expense, breakage and space requirement; tin cans might do, but tin has to be imported and paid for in foreign exchange, which is scarce;

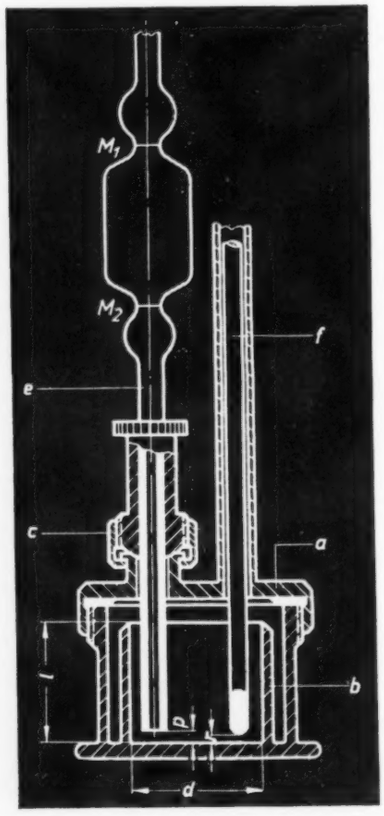
Paper bottles used for lubricating oil in Germany.

besides, the sheet iron from which tin cans are made has other important uses. The only other available material is paper pulp, which is already used for containing various watery liquids. However, the paper bottles now on the market were found unsuitable for use as oil containers, but after considerable research it was found possible to turn out a container that conforms to the military requirements of strength, elasticity, durability, secure closure, and resistance to disintegration in contact with oil. Ability to stand rough usage is of especial importance from the military standpoint. The accompanying illustration shows five oil bottles that were stored under the engine hood of a truck that was driven 3,300 mi. over city streets and country roads; they came through this test somewhat dented, but still oil-tight.

Details of the composition of the pulp used in making these bottles are not given, except that they are made from pulp obtained by reworking old newspapers (thus avoiding use of imported material) and are formed under high temperature and pressure (perhaps with a sodium silicate binder).

Viscosity Test for Diesel Fuels—German Verband fuer Materialprufungen, in OEL UND KOHLE, vol. 15 (1939), No. 5, pp. 96-97.

A tentative standard test for the viscosity of Diesel fuels is carried out with the apparatus shown in the accompanying drawing and which is essentially a Vogel-Ossag viscosimeter. About 15 cc. of the sample is strained through a fine-meshed sieve. The lid *a* is unscrewed, and the well-cleaned inner receptacle *b* is filled nearly to overflowing with the oil at room temperature.



The threaded joint *c* is well cleaned and lubricated with a little valve grease and the measuring capillary *e* is tightly screwed in. Then the threaded cover, which now carries the measuring capillary, but without the thermometer *f*, is put in place, a rubber tube is attached to the upper end of the capillary, and by means of a glass pump sufficient liquid is sucked out of receptacle *b* so that its meniscus will be about the center of the middle enlargement; then the pump valve is closed so that the liquid cannot flow back and the cover is firmly screwed on. The apparatus is then placed perpendicularly in a thermostat, and the thermometer is put in place. When the desired temperature has been established the pump valve is opened and the liquid flows into *b*. If during this manipulation the temperature has not changed more than 0.1 deg. C., the oil is forced up into the capillary by means of air under a pressure equivalent to that of a column of water 60 cm. high. The time, t_c, required to pass from the lower mark M_2 to the upper mark M_1, multiplied by the capillary constant *c*, gives V_d, which is 100 times the dynamic viscosity in centipoises. If the specific gravity at 20 deg. C. is beyond the limits 0.95 to 0.85 the capillary constant *c* must be multiplied by a correction factor. The allowable error is plus or minus five percent.

ECONOMICS

World Consumption of Petroleum and Related Fuels During 1938—V. R. Garfias, R. V. Whetsel and J. W. Ristori, before AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York, February, 1939.

Preliminary estimates indicate that world consumption of petroleum and related fuels in 1938 was close to 1,908,000,000 bbl. or approximately 7,000,000 bbl. less than in 1937. This total does not include military consumption in foreign countries which for obvious reasons is not made public. Foreign military consumption in any one year, however, is approximately represented by the difference between the total production of petroleum and related fuels and the "partial total" consumption above noted, after adding any decrease, or subtracting any increase in stocks in the United States. This "difference," due to the wars in China and Spain and the possibility of armed conflict in Central Europe, foreign military consumption—and possibly additions to foreign stocks—increased close to 70,000,000 bbl. in 1937 over 1936 and remained at this high point throughout 1938. This increase in military consumption and the decline of 35,000,000 bbl. in consumption in the United States were the outstanding developments during the year.

It is noted that with the annexation by Germany of Austria and part of Czechoslovakia the consumption of the country has increased to 53,000,000 bbl., which is about 36,000,000 short of the German production of petroleum and related fuels, and that the Roumanian fields, now more accessible to Germany, produce about 35,000,000 barrels in excess of domestic consumption.

The writers tabulate, for the first time, the countries which individually consume less than 1,000,000 bbl. a year and which are grouped under the heading of "miscellaneous" in the main table. In the new table the countries that consume less than 100,000 bbl. a year are grouped under the heading of "others."

A Design for More Effective Proration—Joseph E. Pogue, in PETROLEUM TECHNOLOGY, vol. 2 (1939), No. 1, T.P. No. 1028; 9 pages.

Proration literally means the allocation of demand among competing producers on a pro rata basis, but the term now carries a much broader significance, for it is employed to describe the entire process by which the production of crude oil in the United States is regulated. As it is now constituted, proration is a planned production measure designed to prevent waste, insure ratable takings, and balance supply and demand. The procedure is administered by state regulatory bodies through use of the police power of the states under authority of state conservation laws; the practice is supported by a considerable degree of voluntary conformance on the part of operators.

Proration has now evolved to the point where it clearly rests upon two thoroughly established principles—conservation and equity; and involves three procedures—curtailment of flow, ratable takings, and an adjustment of restricted flow to balance the measured requirements of the market.

The system is administered by means of a quota system by which it is sought to bring into accord the requirements of waste prevention and market demand, without violation of the dictates of equity. The casual view that proration in essence is purely a stabilization measure is in error, for a substantial degree of the stabilization observable in practice is the automatic resultant of restricted flow and ratable takings instituted on the basis of conservation. It is impossible, for example, to operate an oil pool under back pressure without leveling-out the production curve and thereby flattening the cost curve; in consequence, a smoothing effect is transmitted to price. Under the practice of proration, therefore, entirely aside from the application of market-demand quotas, a significant by-product of economic stability is inevitable.

The technique of proration is adequate for the purpose, all the necessary principles have become established, and a successful outcome waits merely upon a broader cooperation among the oil-producing states and concerted efforts on the part of the regulatory bodies, the Interstate Oil Compact Commission, and the oil operators. Five points are offered for consideration:

1. The development of the optimum rate concept as a yardstick for restricting the individual oil pool.
2. The standardization of the application of bottom-hole pressure readings for the effectuation of ratable takings.
3. The harmonizing of drilling incentives with the requirements of delayed production.
4. The employment of market-demand quotas to reconcile the interim differences between optimum rates and market requirements.
5. The preservation of flexible markets to proportion capital flow to economic requirements, and prevent the development of intra-industry pressures.

The administrators of proration still tend to make the well the ultimate unit of proration, thus placing a premium on the drilling of unnecessary wells; whereas the proper unit is the available oil in the individual property. A change to this basis, effectuated by formulas for lease allocations involving acreage and by scientifically determined schedules for well spacing, would go far toward the correction of the existing trend toward overcapitalization of producing facilities.

RESERVES

United States Oil Reserves Now 17,348,146,000 Bbl.—Annual Report Committee on Petroleum Reserves, AMERICAN PETROLEUM INSTITUTE, February 26, 1939.

The estimate for this year, which takes into consideration only oil deposits known to exist by the results of drilling, is 17,348,146,000 bbl. This includes all grades of crude oil and distillate that are known to be recoverable by present operating conditions and under present economic circumstances. The previous estimate, as of January 1st, 1938, was 15,507,268,000 bbl. After this 1937 estimate was made additional information and new developments necessitated an addition of 2,243,571,000 bbl. to the original estimate, and discoveries of new pools and horizons in old fields during the year amounted to 810,493,000 bbl., making a total gain for the year of 3,054,064,000 bbl. over 1938; deducting the 1938 production, which was 1,213,186,000 bbl., the net gain in reserves was 1,840,878,000 bbl. Figures for the different regions are shown in the accompanying table.

The report puts the present reserves of Texas at 9,447,764,000 bbl., of California 3,188,763,000 bbl., of Illinois 242,847,000 bbl. as against 40,884,000 in 1937.

It is stated that the Committee has proceeded conservatively in estimating the reserves of fields which have been tested by only one or two wells. The report is based on data compiled by more than 60 experienced geologists and petroleum engineers.

Estimated Proved Petroleum Reserves in the United States

(Barrels of 42 gallons)

STATE*	Proved Reserves as of January 1, 1938 (1)	Revisions in Proved Reserves (Including Extensions) in Fields Known on January 1, 1938 (2)	Estimated Proved Reserves in New Pools and New Producing Horizons Discovered in 1938 (3)	Total Columns 1, 2, and 3 (4)	*Production During 1938 (5)	Proved Reserves as of January 1, 1939 (6)
Eastern States:						
Illinois	40,884,000	17,828,000	208,064,000	266,776,000	23,929,000	242,847,000
Indiana	2,622,000	4,178,000	200,000	7,000,000	969,000	6,031,000
Kentucky	38,366,000	.....	5,000,000	43,366,000	5,821,000	37,545,000
Michigan	49,181,000	—3,451,000	16,230,000	61,960,000	19,211,000	42,749,000
New York	60,535,000	—15,000,000	.....	45,535,000	5,045,000	40,490,000
Ohio	28,456,000	1,200,000	.....	29,656,000	3,298,000	26,358,000
Pennsylvania	287,886,000	—70,000,000	.....	217,886,000	17,426,000	200,460,000
West Virginia	28,152,000	.....	.....	28,152,000	3,684,000	24,468,000
Total	536,082,000	—65,245,000	229,494,000	700,331,000	79,383,000	620,948,000
Central and Southern States:						
New Mexico (S. E.)	541,173,000	192,024,000	400,000	733,597,000	35,401,000	698,196,000
Texas	8,247,928,000	1,443,521,000	231,929,000	9,923,378,000	475,614,000	9,447,764,000
Oklahoma	1,212,252,000	98,400,000	26,600,000	1,337,252,000	174,882,000	1,162,370,000
Kansas	601,317,000	5,700,000	65,800,000	672,817,000	59,587,000	613,230,000
Arkansas	192,101,000	—20,978,000	35,200,000	206,323,000	18,077,000	188,246,000
Louisiana	713,434,000	335,764,000	85,870,000	1,135,068,000	94,812,000	1,040,256,000
Total	11,508,205,000	2,054,431,000	445,799,000	14,008,435,000	858,373,000	13,150,062,000
Rocky Mountain States						
Wyoming	265,922,000	14,015,000	200,000	280,137,000	19,004,000	261,133,000
Montana	109,378,000	.....	.....	109,378,000	4,907,000	104,471,000
Colorado	19,125,000	.....	.....	19,125,000	1,412,000	17,713,000
New Mexico (N. W.)	5,414,000	.....	.....	5,414,000	358,000	5,056,000
Total	399,839,000	14,015,000	200,000	414,054,000	25,681,000	388,373,000
California	3,063,142,000	240,370,000	135,000,000	3,438,512,000	249,749,000	3,188,763,000
Total United States	15,507,268,000	2,243,571,000	810,493,000	18,561,332,000	1,213,186,000	17,348,146,000

*These are United States Bureau of Mines figures. No reserves were included for the states of Missouri, Tennessee and Utah for which the Bureau of Mines reports 68,000 barrels production in 1938.

Estimates of World Oil Reserves—V. R. Garfias and R. V. Whetsel, before AMERICAN INSTITUTE MINING AND METALLURGICAL ENGINEERS, New York, February, 1939.

World oil reserves at the end of 1938 aggregated close to 31,000,000,000 bbl., while the total production to the end of 1938 totaled 33,000,000,000 bbl.

Approximately one half of the reserves are in the United States, the fields of Russia, second in importance, accounting for only about 15 percent. It is interesting to note that of the major producing countries, the United States is the only one in which reserves or future productions are less than the past production to date, that only three countries outside of the United States have produced to date over 1,000,000,000 bbl. and that the fields of Texas, California and Oklahoma have each produced more than the total production of Russia, the second ranking producing country.

As world consumption of petroleum aggregated in 1938 close to 2,000,000,000 bbl., the reserves theoretically should be able to provide present needs for approximately 15 years.

World Oil Reserves

	*Reserves (Bbl.)	Production to Jan. 1st, 1939 (Bbl.)
United States:		
Texas	7,500,000,000	5,650,000,000
California	2,800,000,000	5,162,000,000
Oklahoma	900,000,000	4,440,000,000
Louisiana	600,000,000	864,000,000
Kansas	600,000,000	958,000,000
New Mexico	550,000,000	197,000,000
Illinois	280,000,000	455,000,000
Wyoming	280,000,000	454,000,000
Pennsylvania & New York	200,000,000	1,071,000,000
Arkansas	120,000,000	460,000,000
Others	170,000,000	1,473,000,000
Total, U.S.A.	14,000,000,000	21,184,000,000
U.S.S.R.	5,000,000,000	4,025,000,000
Iran	3,500,000,000	878,000,000
Venezuela	2,500,000,000	1,693,000,000
Neth. East Indies	1,600,000,000	838,000,000
Iraq	1,500,000,000	137,000,000
Roumania	700,000,000	835,000,000
Mexico	600,000,000	1,895,000,000
Colombia	400,000,000	230,000,000
Argentina	200,000,000	187,000,000
Peru	200,000,000	240,000,000
Trinidad	150,000,000	164,000,000
Others	550,000,000	957,000,000
	30,900,000,000	33,263,000,000

*No attempt is made to classify reserves into proven, profitable or depreciable.

BOOKS

Physical Constants of the Principal Hydrocarbons—Compiled by M. P. Doss and issued 1939 by THE TEXAS COMPANY, New York; Second edition 152 pages (for limited distribution to individuals and institutions interested in hydrocarbon research).

This set of tables gives the physical characteristics of more than 1,000 definite hydrocarbons that have been synthesized or isolated from natural products. The compiler says the list may not be complete, but even so, it comprises all the saturated or unsaturated aliphatic and cyclic compounds that are likely to be of interest to laboratory workers for some time to come. The hydrocarbons are not only described but references (1397 entries) are given to the original literature. Much of the data given here is not found in other recognized reference works. Oil technologists, who nowadays have to assume the characters of physical chemists and thermodynomists, may consult these tables with ease and advantage.

The Birth of the Oil Industry, by Paul H. Giddens, with an introduction by Ida M. Tarbell; published 1938 by THE MACMILLAN COMPANY, New York; 216 pages. $3.00.

This book covers the early history of the American oil industry up to the year 1870. It is a detailed record of happenings in the wonderful new El Dorado which Drake disclosed to the world. It is an exciting story, full of dramatic action, of fortunes made and lost, and an interesting picture of one of the world's greatest industries in its formative years.

In the introduction Miss Tarbell stresses the fact that only under the American system of free opportunity could the industry have developed at the speed it did.

20TH BIRTHDAY Celebrated by The Guiberson Corporation

S. A. Guiberson, Jr.

Second Generation of Guibersons Takes Reins of Pioneer Oilfield Tool Company.

S. A. GUIBERSON, JR., famous as the launcher of the tool joint, the automatic tubing catcher, the flexible-cup swab, the control head packer and other basically important oilfield tools, has announced the election of his oldest son, S. A. Guiberson III, as president of The Guiberson Corporation, and his son, Gordon G. Guiberson, as executive vice-president and general manager. Mr. Guiberson, Jr., will continue as chairman of the board and his brother N. G. Guiberson, will continue as vice-president.

S. A. (Allen) Guiberson III has served the corporation for a number of years as vice-president in charge of the Diesel engine department, while Gordon G. Guiberson advances to the general management from the position of general sales manager, which he has held for the past two years.

Other important appointments are those of H. M. Haseltine, who has served as general manager for the past two years, as assistant to the president; M. W. Mattison, of the nationally-known accounting firm of Mattison and Davey, as treasurer and comptroller; H. U. Garrett, from the position of assistant sales manager to that of general sales manager; and R. D. Wallis, who has been with the company's accounting department since its founding, to the post of secretary and assistant treasurer.

Mr. Mattison, who enters upon his first official connection with the company, has been continuously connected with the oil business since 1904, and has specialized in public accounting in the industry since 1911, and served the A.P.I. at New York in charge of its division of taxation and accounting from 1920 to 1929.

S. A. Guiberson, Jr., founder of The Guiberson Corporation, ranks as a pioneer of the oil industry. He went to work in the infant oil industry in California at the age of 20, serving successively as rig builder, tool dresser, driller, pipeline builder, pipeline superintendent, and field superintendent. After 16 years in the business he became an independent oil producer and was one of the original discoverers of the Big Muddy field of Wyoming, drilled the discovery well in the Vernon oilfield in Texas, and still owns production and royalty interests in California, Wyoming, Texas, Oklahoma, Kansas, Arkansas and Louisiana.

His principal oil interest is the Guiberson Oil Company, in East Texas, but he is also president of Home Ranch Petroleum Company and has been a director of Superior Oil Company of California since shortly after its incorporation.

Mr. Guiberson is president of the Guiberson Diesel Engine Company, which for the past few years has been engaged in manufacturing Diesel radial aircraft engines for the United States Army and Navy under restricted orders. Some of these engines, recently released from restrictions, soon will be offered for sale to the public.

S. A. (Allen) Guiberson, III.

Gordon G. Guiberson.

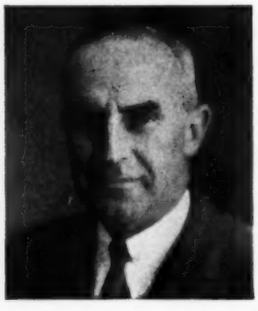
N. G. (Nat) Guiberson.

LANE-WELLS CHANGES

D. S. JEPPSON has been elected to the board of directors and has become controller of Lane-Wells on April 15th, 1939. Mr. Jeppson has been auditor of the company since 1933 through the firm of D. S. Jeppson, C.P.A., and Associates. M. E. Montrose, formerly Gulf Coast manager, has been appointed general sales manager with headquarters in Los Angeles. Morton T. Higgs, Gulf Coast sales manager, will replace Mr. Montrose as Gulf Coast division manager with headquarters in Houston and will have charge of the company's operations in Texas and Louisiana.

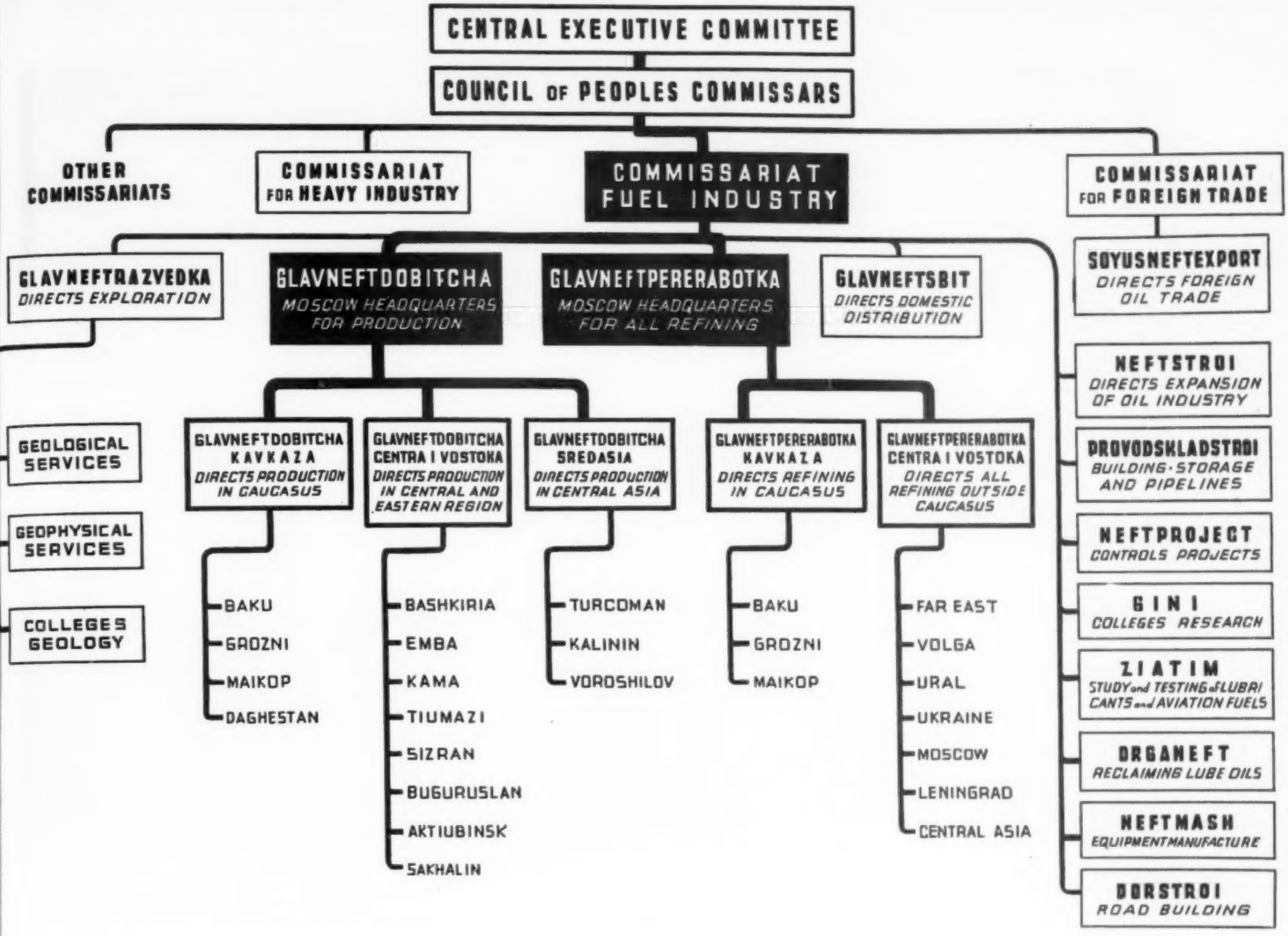
H. M. Haseltine.

M. W. Mattison.



H. U. Garrett.

R. D. Wallis.



Graphic description of the organization of the Russian oil industry and its relation to the Soviet government—from World Petroleum Register, 1939.

U. S. S. R.

Official Figures for Soviet Oil Operation

1939	Production bbl.	Daily Average bbl.	Run to Stills bbl.	Drilling feet
January	17,000,000	548,400	16,400,000	420,000
February	18,000,000	642,857	15,900,000	500,000
March	18,200,000	587,097	16,000,000	520,000
Total 1938	206,125,000	564,727	190,896,000	5,390,000
Total 1937	202,856,661	555,772	187,121,389	6,244,660
Total 1936	199,634,921	545,450	180,582,274	6,958,916
Quota 1938	244,215,000*	666,066	215,055,000	not available
Quota 1937	234,450,000	642,329	208,285,000	9,240,000
Quota 1936	222,345,000	607,000	182,250,000	7,100,000

*Crude oil and gas

Russian Oil Survey—Part II

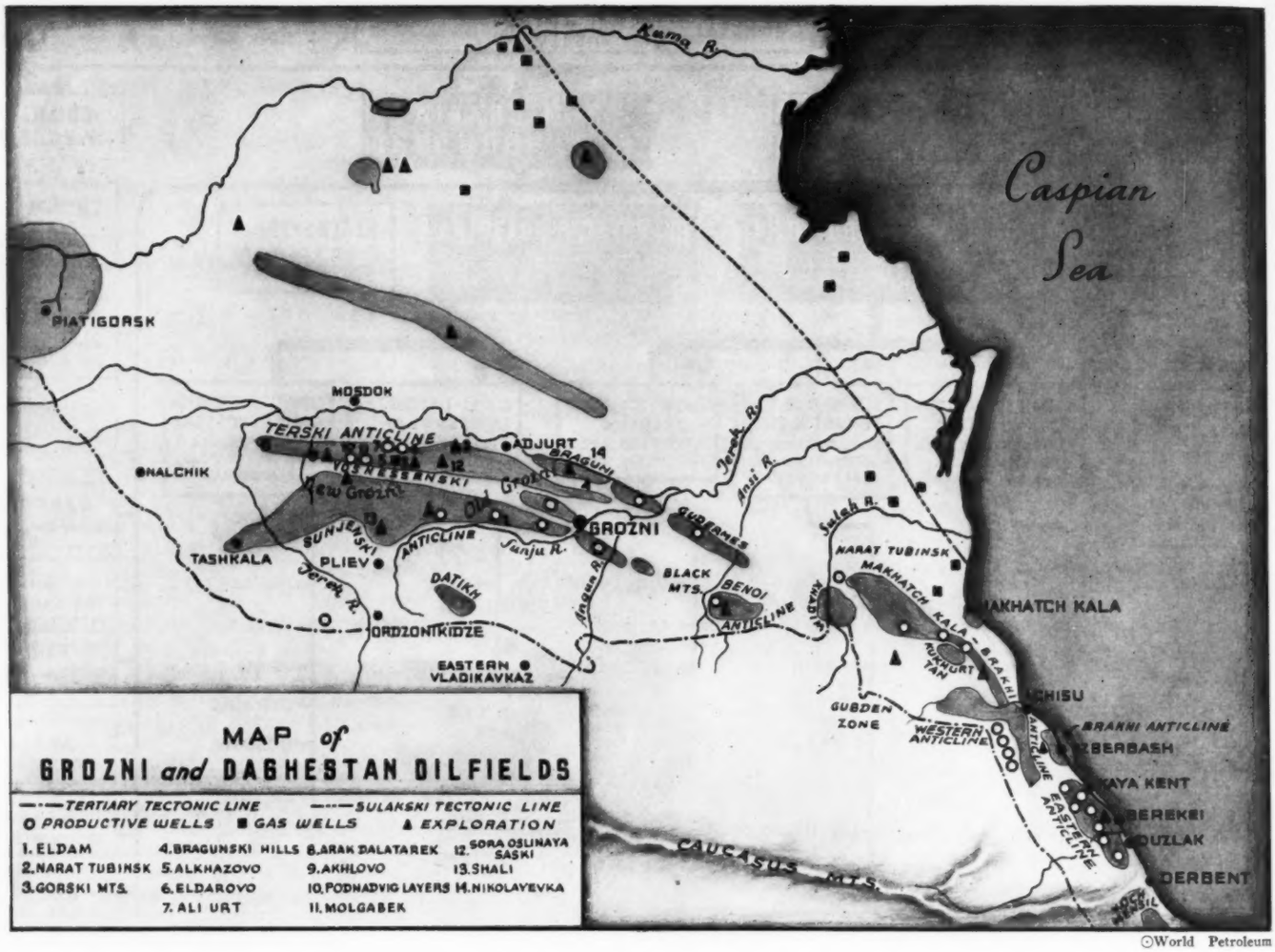
Second of a Series Dealing with the Soviet Petroleum Industry in All Its Phases. This Article Surveys the Grozni Oilfield Group, Second Largest in Russia. Next Month Mr. Wegrin Discusses the Maikop Fields.

GROZNI

THE second largest oilfield group of the U.S.S.R. is Grozni, in Circasia, west of the Caucasus Mts. In ancient times this territory formed a link between Mediterranean civilizations and the East. Trading posts were established there and colonies of Tartars, Mongols, and Russians were attracted by the fertility of the plains and the geographical location. Prevalently agricultural for so long, the area now is undergoing industrialization.

Physiography—

The southern part of Circasia consists of foothills of the Caucasus range, but most of the area is covered by fertile plains. A great part of these steppe lands are treeless, except near streams, but the Don valley and the northern regions have a variety of trees and vegetation. The whole area is rich



©World Petroleum

Map of the Grozni and Daghestan Oilfields showing both existing oilfields and the adjacent petroliferous areas.

in minerals such as lead, zinc, silver and petroleum, while it is the Rostov-Don region which supplies most of the agricultural machinery used in the Soviet farmlands. This part of the Caucasus has a fairly high rate of rainfall, and has about 275 warm and sunny days during the year. The main oil port on the Black Sea is Tuapse, and on the Caspian Sea is Makhatch Kala (formerly Petrovsk).

Volcanic evidences are frequent and are noteworthy at Elborus (16,000 ft.) and Kazbek (14,000 ft.) All large rivers originate from the central part of the Caucasian range and some are torrential; the Mozmita, Pzou, and Bzyb drain the area west of Elborus; the Rion, Ingur, Kviriba and Ingur drain the territory between Elborus and Kazbek. Most important are the Kuban and Terek, south of which is the Sanji on which the city of Grozni is situated. The Kuma goes further to the north and terminates in the Caspian Sea.

History—

There are about 200 petroliferous regions in Circasia, of which the known fields under operation are Grozni, Maikop, Daghestan and Kuban-Black Sea (Crimea). Of all these, Grozni is the oldest and most important.

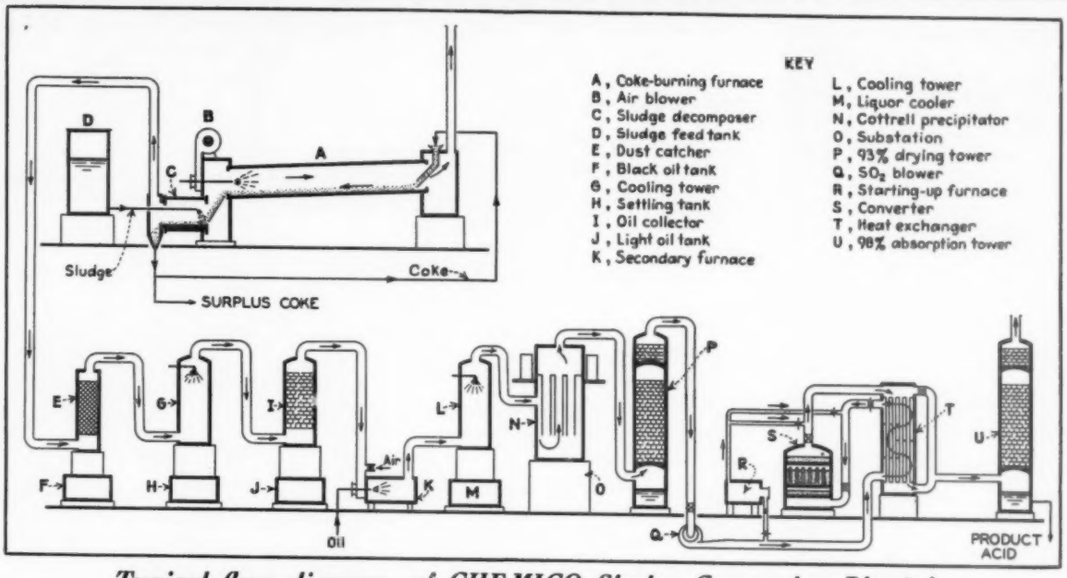
Grozni is the capital of the Tchchen autonomous republic and is the habitat of the Don Cossacks. The city is on the Sunji river and is connected by rail with Vladikavkaz and Makhatch Kala. Oil was produced from hand-dug pits when Russia took possession of the Caucasus in 1821. The original fields of the Grozni group were opened in 1893 and consisted of some properties on a range of hills about seven miles northwest of the city. The anticline coincides approximately with these hills extending northwest and southwest. The first well was drilled mechanically in 1893 and produced from 440 ft. while the second, flowed 1,500 tons daily from about 500 ft.

Grozni oil flows were so great that a first it was anticipated that the field would supersede Baku in importance, but it was found that the wells were comparatively short-lived and dried up quickly. However, the Grozni fields covered a larger area and operation was not so restricted as at Baku.

In 1913 the new Grozni fields were put into operation and extended to Vosnessenski, some 60 mi. from the city. Lack of adequate roads retarded development of these fields, and in 1914 the entire field only covered 400 acres.

Composition—

The oilfields have been reorganized and extended under the Grozni oil trust (Groznefte) which is operated under the Caucasian producing division of the Soviet petroleum industry (Glavneftdobitcha Kavkaza). There are three main producing areas in the Grozni group—Terski, Vosnessenski, and Sunjenski; each of which comprises several individual fields. Today the Grozni oilfield group is composed of the old Grozni fields, and the October or new Grozni fields of Voznessenski, Molgabek and Gorski Mt. The Daghestan fields,



Typical flow diagram of CHEMICO Sludge Conversion Plant for the regeneration of concentrated sulphuric acid from acid sludge

CHEMICO ACID SLUDGE CONVERSION

What the process is and what it does

OPERATING PRINCIPLE and ACCOMPLISHMENTS

A CHEMICO Sludge Conversion Plant produces clean acid, direct from the raw unseparated acid sludge. The acid produced may be 98% H_2SO_4 or of any desired higher commercial strength, regardless of the initial strength of the sludge. The output of the plant requires no further purification or concentration.

The raw sludge is decomposed by heat to strong sulphur-dioxide gas and a dry granular coke. The gas is scrubbed clean of impurities (with recovery of the oil content) and converted into sulphuric acid in a contact acid production unit employing long-lived vanadium catalyst. Operation is continuous and the equipment is sealed throughout to prevent escape of fumes. **Sludges that cannot be separated or utilized profitably by former processes are satisfactorily converted into strong clean acid.** The residue, petroleum coke, is usable as fuel and equal in worth to any other of the same calorific value. Everything is profitably utilized, and as nothing remains for disposal, every bad factor of disposal is absent.

CHEMICO Sludge Conversion plants are individually designed for the requirements of the refinery served and full responsibility is assumed by us for all material and equipment. Acceptance is asked only after the guaranteed performance is proven by impartial test.

THIS unique process offers to refiners the only satisfactory solution to the acid sludge problem.

Previous disposal of the sludge to waste meant complete loss of recoverable material, non-productive handling expense, and probable atmospheric or water pollution with accompanying grave risk of prosecution. Previous acid recovery methods on the other hand were unsatisfactory, because further processing for purification, for removal of hydrocarbons and for concentration to attain necessary strength frequently made the recovered acid cost more than it was worth.

That the CHEMICO Acid Sludge Conversion Process completely overcomes these objections is proven by the erection in 1937 of two large installations in the United States and one abroad, all ordered after thorough checking of a constantly operated first plant which was started in 1932. The new installations, to which we gladly refer, have already earned and received the high commendation of their owners.

If your acid requirement exceeds 20 tons per day, let us submit costs and operating data. Preliminary conference involves no obligation.

CHEMICO
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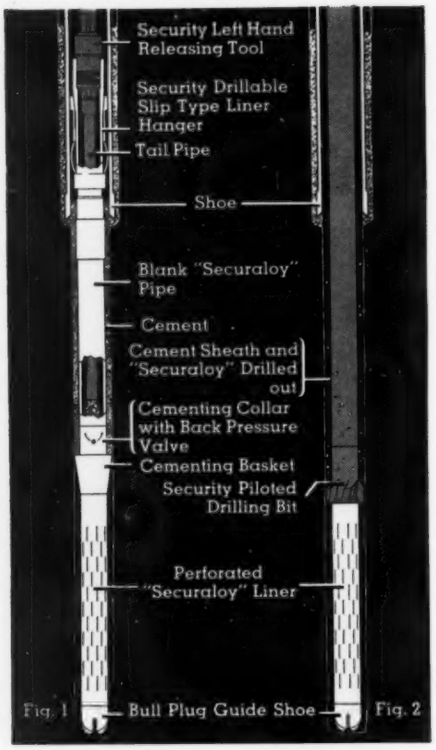
MAIN OFFICES: 30 ROCKEFELLER PLAZA, NEW YORK

European Representatives: Cyanamid Products, Ltd., 14 Finsbury Circus, E.C.2, London, England

CHEMICO PLANTS are PROFITABLE INVESTMENTS

NO. 5 OF A SERIES SHOWING HOW "SECURALOY" INCREASES DEVELOPMENT EFFICIENCIES



SECURALOY

CUTS EXPLORATORY COSTS!

Here is the way many operators doing exploratory work are cutting their costs and at the same time increasing the accuracy and safety of their testing operations.

When they drill into a sand with productive possibilities, instead of setting and cementing a string of casing and running a liner, they cement a combination liner and casing string made of "Securaloy." As illustrated (fig. 1), this string is cemented in place through ports in the casing at the top of the producing zone, using a basket below the ports, if desired.

By using a Security Left Hand Releasing Tool the operation is made extremely simple and positive, for this tool not only assures positive release but has a built-in packing device and tail pipe connection that facilitates the cementing operation. At excessive depths equalizing ports should be provided in the blank section of the string and a swab cup placed on the tail pipe to prevent by-passing of the cement through these ports during the cementing operation.

After the combination string is set the well is placed on production. If the sand proves productive, it can be produced as long as desired through the "Securaloy" Combination String.

But if the zone proves non-productive—or not sufficiently productive to warrant further development at the present—the entire combination can be quickly drilled up (fig. 2), circulated out of the hole, and the well completely cleared for further drilling operations!

MONEY-SAVING ADVANTAGES

Notice the important savings which this method makes possible. In the first place, a full string of casing is saved each time a production test is made. That alone is an important economy.

But consider also that if the zone is non-productive the combination casing-liner string can be completely removed and the drilling carried on *without reducing hole size.*

And there is this additional feature—since the liner is part of the casing string, maximum size pipe can be used in the producing zone, assuring full unchoked production flow from the test sand—a vitally important point regardless of whether the zone is being fully produced or merely tested!

Full particulars on this or any other "Securaloy" application will gladly be sent upon request.

SECURITY ENGINEERING CO., INC.

Sweets Reamers • Securaloy • Securaly Drillable Products

Achisu, Kaya Kent and Izberbash, have been separated and operated as a unit under Daghestaneft.

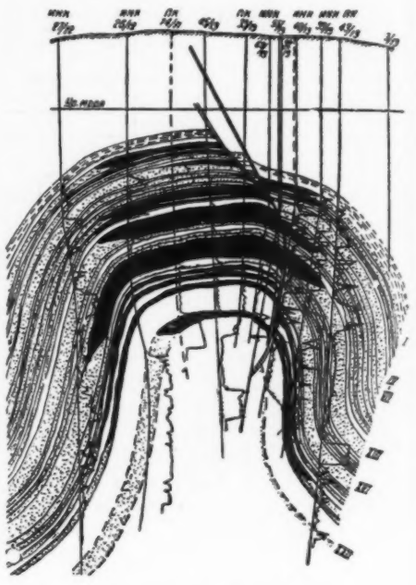
Stratigraphy and Geology—

The Grozni oilfields are of Tertiary age, and the deposits are mostly Miocene strata in which sandstone is associated with shale, sandclay, limestone, and dolomites. Geoligically the structure is simple and in the shape of a fan—crystalline rock which prevails in the center disappears toward the east, and beneath these are strongly folded Paleozoic and Jurassic schists. In the north the folded beds are followed by a zone of Jurassic formations which decline gently toward the plains. The northern Mesozoic zone is broad and thrown gently into simple folds like those of the Jura Mts. In geological sequence the Mesozoic folds of the north are followed by Tertiary deposits which are nearly horizontal. Tests of the strata at various places taken at right angles to the hills exhibit different features, but almost everywhere the slope of the anticline in the north is rather steep while gentle on the south.

Many wells were abandoned as failures and this led to the belief that the formations were faulty or of more complex nature, but there were no surface indications to that effect. The dip on the northern side, and alluvial matter collected on the southern side together with sedimentary beds, had hindered the extension of the fields for a considerable time, until deep drilling became a factor of importance. The Grozni strata differs from those at Baku in the way that they are highly impregnated with lime, giving them a marly character. The well-defined petroliferous sands so prevalent at Baku are absent although the sandy strata found gives indications of oil when washed. Up to about a dozen horizons are suspected, of which five or six are operated, and there are no signs that the 12th horizon had been reached.

Under the north Caucasian depression come the complex structures of the Terski anticline, the calcareous domes of Khadim and Kukhurt Tan, the Brakhi anticline running from Achisu to Izberbash, and the eastern anticline of Daghestan.

The Terski anticline is a number of individual systems of thrusts and bends, underthrust and overthrust, and among these several formations are petroliferous. The regions of this anticlinal formation are Alkhazovo, Eldarovo, Molgabek, Adjurt, and Vosnessenski, all of which are oil-bearing, and these are natural frontiers which divide the folds from the great northern Caucasus depression.



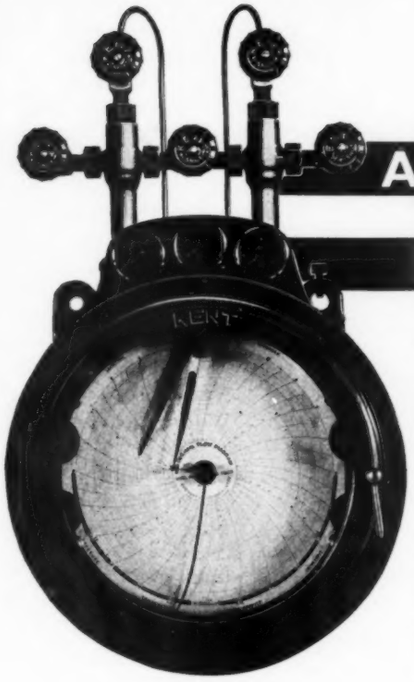
Cross-section of Terski Ridge.

The second group is along the Sunjenski anticline, including old and new Grozni, the Benoi structure, the calcareous elevations of Saltan, Eldam and the western anticline (Daghestan). To this group also belongs the Kabristan elevation. In the central and more elevated part of the Sunjenski anticline, oil seepages and outcrops are evident on the surface, but owing to inaccessibility have been studied but little, and only by the similarity to Terski properties has it been assumed that large oil accumulations are conserved as deposits. To this second group also belongs the Benoi anticline known as the Black Mts. and from Benoi to Apsheron a series of bends fill all Tertiary sediments. Most of the formations are denuded on the surface, but the oil-bearing strata are likely in the Maikop formations which are still to be studied.

The third group is the Maikop monocline of the Black Mts. Two basins formed at Dathik between northern Sunju and eastern Vladikavkaz are notable where the formations form an anticlinal fold. Daghestan has eight units in this group: the Maikop struc-

Operations of the Grozni Oil Fields

	Up to 1914 Production (Tons)	Up to 1914 Wells (No.)	1914 to 1920 Production (Tons)	1914 to 1920 Wells (No.)	1920 to 1937 Production (Tons)	1920 to 1937 Wells (No.)	Total Production (Tons)	Total Wells (No.)
Old Grozni	13,500,000	650	6,000,000	216	10,000,000	419	29,500,000	1,285
New Grozni	15,000	5	2,000,000	65	43,000,000	815	45,000,000	885
Vosnessenski — Molgabek — Braguni — Gudermess	1,600	15	18,000	30	2,000,000	140	2,018,000	185
Berekei — Kayakent — Izberbash	91,000	78	.....	....	100,000	200	200,000	278



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ture, the Narat Tubinsk zone of thrusts of the monocline, the Makhatch Kala-Brakhi anticlinal elevation, the Brakhi anticline between Achisu and Izberbash, the eastern anticline of south Daghestan, the Gubden zone of south Daghestan, the Tertiary monocline of north Daghestan, and the gas fields of the Caspian lowlands.

The known oil deposits of Grozni are divisible into three groups: (1) anticlinal deposits in which all oil is surrounded and supported by contouring water, filling the arch of the anticline; (2) brim deposits where the oil is supported by contouring water and protected by the surface of the break which hinders its further migration; and (3) suspended monoclinal deposits in which the migration of oil was prevented by lithological changes and by insufficient support of water from the sides. The October or old Grozni fields belong to the first group, while Molgabek, and Vosnessenski (new Grozni) as well as Kaya Kent belong to the third group; Molgabek deposits are also surrounded and supported by gas.

Soviet geologists assert that the complex Paleogene calcareous sediments and lithological clays of the Lower Maikop elevations and foraminiferous layers, as they extend and dip in the north Caucasus, corroborate the view that Circasia belongs to the Paleogenic tectonic face, which in the Tertiary period caused perturbances of the sea bottom, and was followed by ingression in the foraminiferous and Lower Maikop period. The absence of ponts over large areas of north Caucasus and Daghestan indicates that these large areas were land. Anticlines come up to the surface in the form of elevations which must have been subjected to destruction by upper agents and completed in the form of transgressions which have brought up various formations of different ages and lithology.

The synclines have conserved all thicknesses of the sediments, serving as a protection and influencing the formation of folds as well as the direction of dislocations which have split the nearby anticlines. Disjunctive dislocations cutting Tertiary anticlines were thrust up with considerable amplitude of vertical movement of the mass and comparatively insignificant horizontal dislocation.

Commercially oil-bearing Tertiary formations in the north Caucasus are the Mediterranean and Maikop layers, of which the latter is the deeper. The deposits are embedded in compact sands and the petroliferous stratum is under hydraulic pressure while there their condition coincides with the horizontal or tectonic elevation of the oil layers, which is favorable for its study or commercial preparation. Lower Maikop formations are petroliferous at Maikop, while at Daghestan, Benoi, Berekei, and

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For complete details see 1939 Composite Catalog, or communicate with

*In the patent infringement suit by Otis Pressure Control, Inc. and others, against The Guiberson Corporation, tried March 13th, 1939, the U. S. District Court decreed: **"That patents to Collins 1560763, MacClatchie 1708316, and Otis 2052939, are NOT infringed by respondent" (The Guiberson Corporation).**

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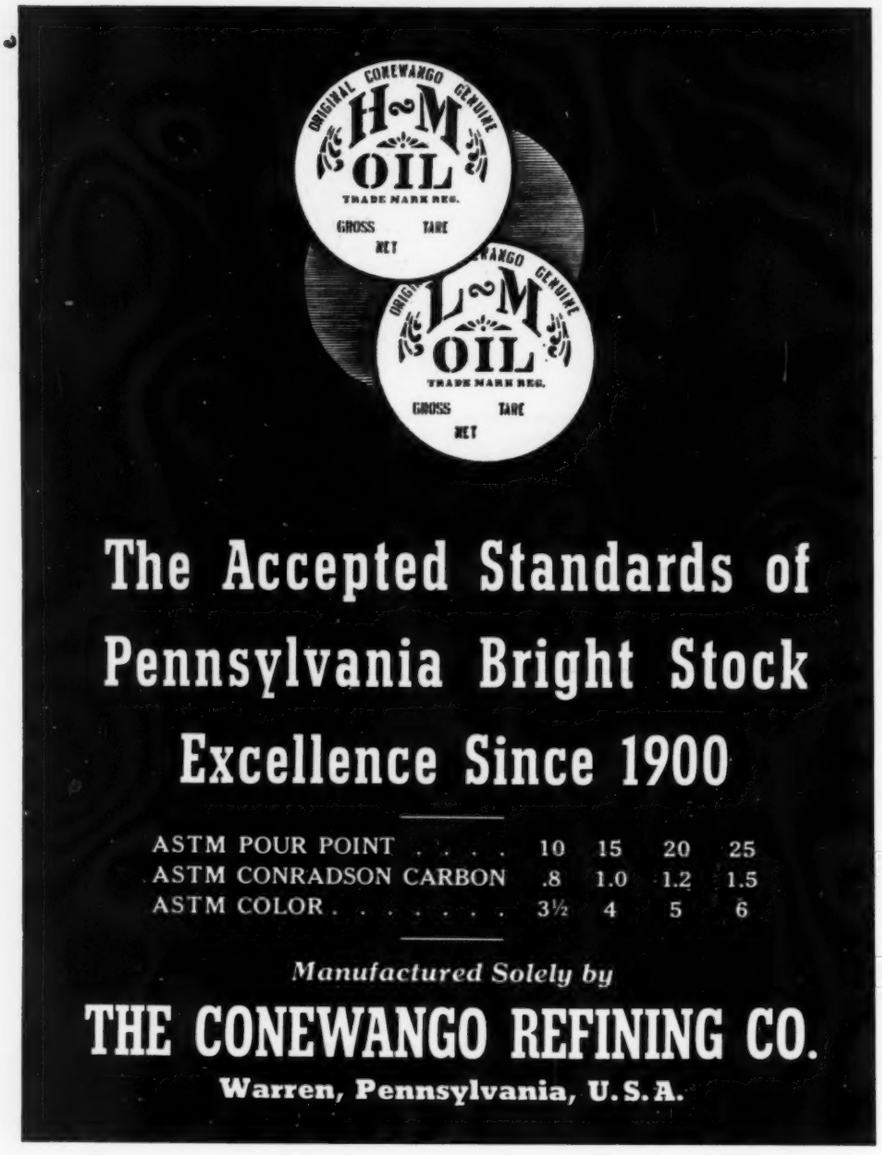

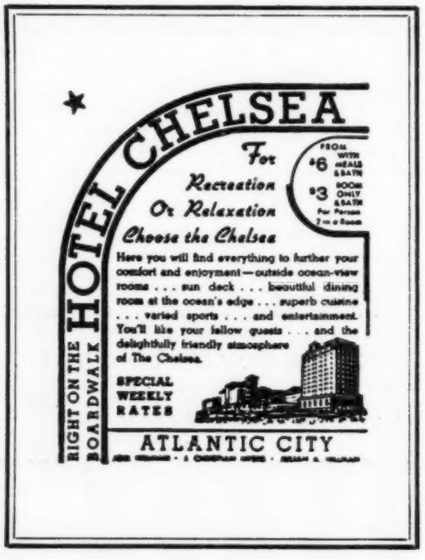
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Kosh Mensil they yield gas. The layers are complex and the sediments have to be studied as to the conditions under which they were formed.

The Maikop layers overlie Paleogene sediments. The Paleogene extends from Caucasus and Crimea to Roumania and Galicia where the dark lime formations with fossil fish are also the layers which bear oil.

The Gorski Mt. and Molgabek fields, adjacent to South Vosnessenski in the Terski hills, are reported to be prolific from below the XVII layer. They are of Padnadvig nature and require 7,000 to 8,000 ft. wells. According to the late Prof. Gubkin, noted Soviet geologist, Molgabek field could be readily extended over the Sunjenski hills in an easterly direction and somewhat north of the old Grozni fields, in a region between Solenaya Balka and Tashkala, and again further north to the Bragunsk hills. Gorski Mt. field is likewise on the Terski ridge, about 45 mi. from Grozni and 20 mi. from Molgabek. Development of both Gorski Mt. and Molgabek is retarded by the complicated geologic structures and by lack of transportation facilities.

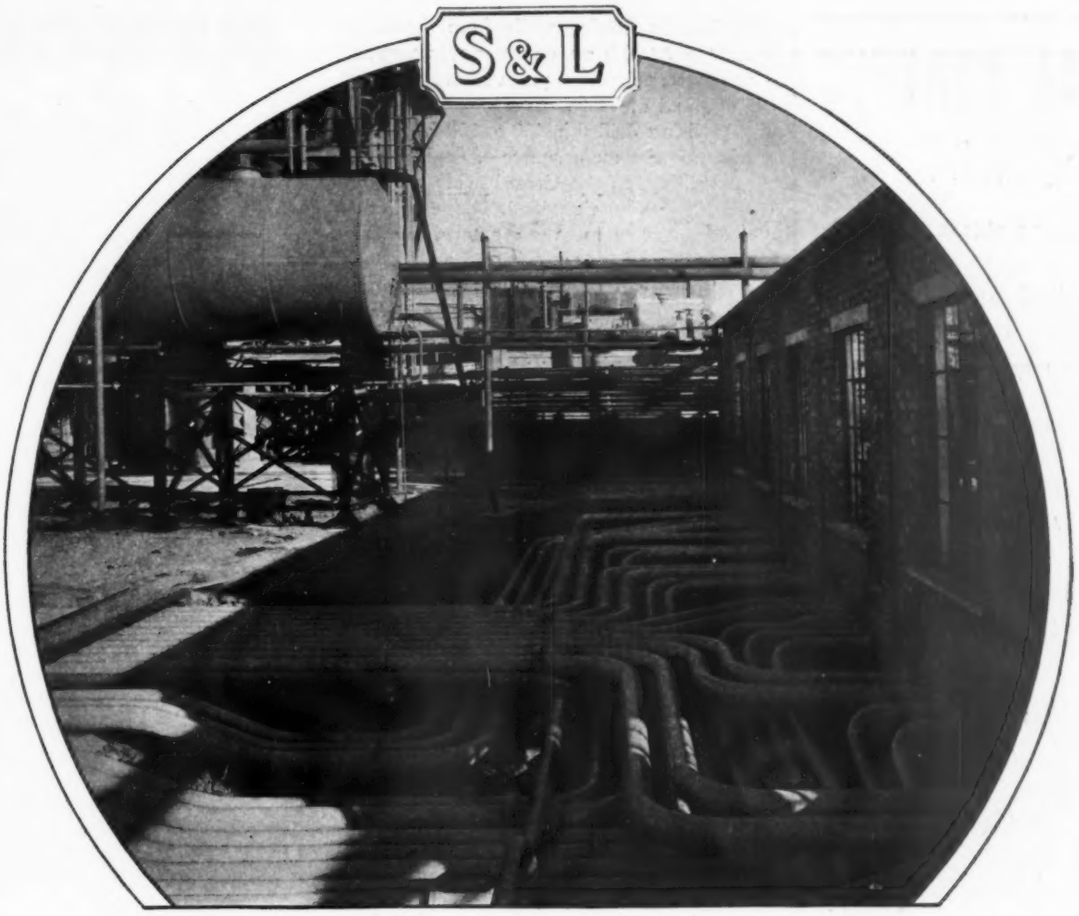
Drilling and Production—

Grozni oil sands average 175 ft. in thickness, with 25 percent porosity and 12.5 percent oil content. Gas-oil ratios vary from 95 to 140 cu. ft. per bbl. and ultimate recovery of the oil may be as much as 75 percent where water displacement is employed.

Up to 1937 some 80,000,000 tons of crude had been produced from the Grozni oilfield group, of which about 95 percent came from old and new Grozni. Until 1913 production had come from old Grozni, although drilling had been carried out at Vosnessenski, Terski and Benoi as well as Berekei, Kaya Kent and Izberbash in Daghestan during the war years without material results, due to the tectonics which require deep wells.

Grozni crude is paraffine base and is notable among Soviet crudes because it contains about 24 percent of gasoline, while some grades such as Molgabek contain about 40 percent. After the war and up to 1932 Grozni showed a steady growth to 9,000,000 tons annually and was looked upon as the main source of Soviet gasoline. After that date output declined to the point where the fields produce only a little more than 3,000,000 tons. Altogether there are about 3,000 wells in the Grozni group and more wells are being sunk as the fields are extended.

In field practice Grozni operations are similar to those employed at Baku in the form of rotary drilling and rig building as well as methods of mechanical production.



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